ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL.

VOL. XLIII. No. 22.

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THE DATE FOR STOPPING THE POLLUTION of the Passaic River was discussed by representatives of the several localities and others at a meeting of the New Jersey State Sewerage Commission on May 28. The Commission stated that it proposed to take action under the law to stop the pollution of the river. The fixing of time to be given for the purpose is in the discretion of the Commission, except that if it issues such an order, as it stated it intends to do, the pollution must cease within five years thereafter. The representatives of the several communities named from 1 to 5 years as the time they need to provide other means of disposal, depending upon just what was required to satisfy the Commission. As a citizen of one of the towns in question, Mr. M. N. Baker, of the editorial staff of this journal, suggested that Orange, Montclair, Glen Ridge and Bloomfield had done something already to relieve the river, through the provision of a storage reservoir to enable them to discharge the sewage from their joint outlet sewer on outgoing tides. This reservoir, although not built for the purpose, undoubtedly acted to some extent as a septic tank. Mr. Baker suggested that the Commission improve the opportunity thus afforded to study the septic tank experimentally. Mr. G. Everett Hill, of the City Wastes Disposal Co., on request from the Commission, described a septic tank and "Dibdin contact filters" designed by him for Collingwood, N. J. By means of a lateral discharge through 50 ft. of coke he stated that he obtained the same effect as to successive action of different bacteria as is claimed for the Scott-Moncrieff filters. The date for stopping the pollution was not fixed at the meeting.

STREET SPRINKLING EXPERIMENTS AT SAN Francisco, carried on by the Merchants' Association, have brought out some very interesting points. The association has advocated municipal sprinkling for a number of years, but not until the new charter went into effect, last January, was there any immediate prospect of such action. The new charter requires the board of public works to let yearly contracts for sprinkling such of the business streets as it sees fit. The May number of the Merchants' Association "Review" states that street sprinkling in San Francisco presents some unusual problems, due largely to the clouds of dust brought from the Western Addition hills and the smooth bituminous rock pavements on some of the streets. To determine what system of sprinkling was best adapted to the city, and to show the people the advantages of thorough sprinkling, in place of the haphazard practice resulting under private contracts, the association decided to put eight sprinkling carts in service. The experience and conclusions, as related to a single street, are given by Mr. L. M. King, Superintendent of the association, in the May "Review" as follows:

> One of the main problems to be solved was the best method of sprinkling Market St. from Second to Van Ness Ave. The difficulties to contend with here are: (1) a smooth pavement which was easily rendered slippery; (2) the strong westerly and northerly winds blowing down the cross streets from the Western Addition strike the buildings on the south side and blow all the dirt from the south side of the street over to the north side, and (3) the winds prevailing in the afternoon are so strong that when the street is sprinkled with a fine enough spray to lay the dust and still not make the pavement slippery, the water is so rapidly evaporated that the pavement is dry and dusty before the cart can complete its trip and return. After several days' experimenting, it was found that the proper way to sprinkle this street is to sprinkle heavily between the car tracks, to sprinkle the north side of the street with a heavy spray next to the gutter and a light spray outside, and to leave a strip about 10 ft. wide next to the outer rail of the car tracks entirely unsprinkled. The south side of the street is not sprinkled at all. Dust blowing across or down the street is caught and held by the wet pavement and gutter on the north side, and heavily loaded teams have a dry strip outside of the car tracks upon which they can travel without slipping.

THE COMPARATIVE DURABILITY OF WOOD AND asphalt pavements has been reported on by Mr. D. J. Ross, City Engineer of London (the original city, as distinguished from the metropolitan area under the London County Council). Mr. Ross prefers asphalt to wood, adhering to his report of a year ago in favor of using asphalt on the Holborn Viaduct. The traffic on this street is about 12,000 vehicles in twelve hours. In the report in question, which is given in full in the "Contract Journal" for May 16, 1900, Mr. Ross says that ordinary deal block pavements have been used in the city of London since 1871, the blocks being mostly 3 × 9 ins. × 6 ins. deep, generally creosoted, laid with bitumen joints on Portland cement foundations. In all cases the contractors have agreed to maintain these pavements for two years without charge and for 15 years additional at a fixed charge, varying with the local conditions. Mr. Ross says that in his experience "the carriageways in streets of considerable traffic have had to be relaid at intervals of from five to seven years." As to Australian hard woods in the city proper, except for 304 sq. yds. laid in October, 1893, none have been down more than 4½ years, and most of those laid only three years or less. All such blocks laid in 1896 or earlier are reported as either in "fair condition" or "showing signs of wear," the blocks laid in 1893 being "rounded by the traffic." In all about 25,000 sq. yds. of hard wood blocks have been laid. Outside the city proper hard wood blocks laid in Tottenham Court Road in December, 1892, "had worn very unevenly" by June, 1899, or in 6½ years, besides which "the noise caused by the traffic was very great, and the pavement was being extensively repaired."

The first asphalt pavement was laid in the City of London in 1869, on Threadneedle St., adjacent to the Bank of England. This was renewed at the end of 17 years. Most of the main thoroughfares of the old city are paved with asphalt, under 17-year maintenance contracts, as already noted for the wood pavements. In nearly all cases the asphalt has not been entirely renewed until after the expiration of the 17 years, and in some minor streets the maintenance contracts have been extended, so the old pavements have been in use for nearly 30 years, without entire renewal.

THE FIRE DEPARTMENT OF NEW YORK, in its report for 1899, shows that it is now responsible for the protection of a total of 196,800 acres, of which only 13,487 acres are situated in Manhattan Borough, or New York proper. The Bronx covers 25,270 acres; Brooklyn, 42,035 acres; Queens, 70,347 acres, and Richmond, 36,661. This area presents a water front of 227 miles, along which are stored many millions in value of merchandise. To handle fires occurring in this region there are 94 engines and hook-and-ladder companies and 1,375 officers and men in the Boroughs of Manhattan and the Bronx; and the Boroughs of Brooklyn and Queens have 80 such companies and 1,029 officers and men. There are six powerful fireboats in commission. The Boroughs of Richmond and Queens have a volunteer fire service of 1,725 and 2,000 officers and men, respectively.

THE 39TH ST. SEWER TUNNEL at Chicago is to be closed at the ends of the completed work, by means of brick bulkheads. This will be done to avoid the expense of maintaining the air pressure until such time as arrangements can be made for resuming the work. The Chicago Star Dredging & Construction Co., which had the contract, has been put in the hands of a receiver, and the company's bondsmen have as yet failed to make arrangements for proceeding with the work. The tunnel was being driven through quicksand by means of the Hastings shield, and air pressure had to be maintained to support the face of the excavation.

THE CONTRACT FOR STEEL PIPE for the new water supply works for Jersey City has been awarded to the T. A. Gillespie Co., of Pittsburg and New York. The contract for the tunnel through the first Watchung Mt. has been let to Reehill & Edwards, of Jersey City. Mr. Edlow W. Harrison is the engineer for the general contractors, the Jersey City Water Supply Co., and Mr. Garwood Ferris is supervising engineer for the city.

THE EXPORT OF AMERICAN MANUFACTURES, for 1900, will exceed $400,000,000, says the Treasury Bureau 20% of the total exportation in 1889 to about 45% in 1900. of Statistics. The record for April, 1900, alone is $40,000,000. Manufactures of metals have increased from less than In 1880 the value of exports of manufactures of iron and steel was $14,716,524; in 1900 it will exceed $100,000,000. The first ten months of the fiscal year 1900 show a gain marked. In 1880 the total export of iron rails was but 7 tons; in 1898, it was 2,769 tons; the export of steel rails rose from 7,398 tons in 1889, to 229,783 tons in 1898, with an increase in value rising from $235,387 to $4,613,376. The first ten months of the fiscal year 1900 shows a gain of about $2,000,000 over the corresponding months of 1899; the latter year showing a total value of $5,298,125.

AMERICAN-GERMAN COMMERCE, says the U. S. Bureau of Statistics, is gaining. American exports to Germany, for the nine months ending with March, 1900, amounted in value to $142,781,489, as compared with $123,222,617 in the same months of the last fiscal year. In 1895 this total was $72,894,650, and the gain has been continuous since then. Our greatest gain over 1899 was in the export of cotton, corn, copper, petroleum and tobacco; with lesser gains in agricultural implements, seeds, timber, builders' hardware, electrical and scientific instruments, sewing machines, etc.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Lake Shore & Michigan Southern Ry., at Westfield, N. Y., on May 23. A fast mail train ran into an open siding while going at a high rate of speed. The engine and several cars were derailed, and the engineman and fireman were killed.

AN EXPLOSION IN THE COAL MINE at Cumnock, N. C., on May 22 resulted in the loss of 22 lives. It is supposed that the explosion was due to fire-damp and a defective safety-lamp.

THE "LA BOURGOGNE" DISASTER CLAIMS may be cut off if the petition of the French company to the U. S. District Court is favorably acted upon. There are 84 unsettled claims aggregating $1,500,000; and the steamship company now asks that the damages assessable be limited to the remaining value of the ship and freight. As all that was left of "La Bourgogne" was one boat and a life-raft, and the freight went down with the ship, the liability would be practically nil.

RAILWAY COLLISIONS, on roads engaged in interstate traffic, must be fully reported to the Interstate Commerce Commission, if the bill approved by the House Committee of Congress becomes a law. Monthly reports of all accidents to passengers or employes would also be required. The purpose of the law is to endeavor to determine the chief causes of collisions and accidents on railways.

FAST CONTINENTAL RAILWAY TRAINS are noted in the "Journal of German Engineers." What this journal claims to be "the fastest train in the world" runs on the Northern Railway of France; it makes the 82 miles between Paris and Amiens in 1 h. 15 m., without a stop. This is equal to about 65 miles per hour. Another train on the same line runs from Paris to Calais at a speed of 51 miles per hour; and another still, between Paris and St. Quentin, at 55 miles per hour. On the Orleans railway two trains between Orleans and St. Pierre make 51 and 57 miles per hour respectively. On the Southern railway of France no less than six trains have a speed of 56 miles per hour, or more. In Germany, the law of 1897 forbids a speed exceeding 90 kilometers, or about 56 miles per hour. The fastest train in Germany runs between Wittenberg and Hamburg, at the rate of 52 miles per hour.

THE NORTHWESTERN ELEVATED RAILWAY, of Chicago, is to be opened on May 31. This line starts from a connection with the Union loop, in the business center of the city, and extends through the residence district on the North Side, to Wilson Ave. It is a little over 6¼ miles long, excluding the loop. It is a 4-track structure for nearly 6 miles; and express trains are to be run over the 6¼ miles in 25 minutes. The power plant, when completed, will furnish 7,000 HP. electric. Mr. Charles T. Yerkes is the largest stockholder in the new line; and he estimates that it will carry 65,000 passengers per day and earn $1,200,000 per year.

THE LAKE STEAMER "JOHN W. GATES" recently left Duluth for the ports of Lake Erie with 7,075 gross tons of iron ore. This is equivalent to more than 8,000 net tons; and she carries this on a loaded draft of 17 ft. forward and 18 ft. aft. With a draft of 20 ft. she will carry 9,000 net tons; but this load is prohibited by low water. This steel ship is one of the fleet of the American Steamship Co., belonging to the American Wire & Steel Co. The sister ship, "Hill," carries a similar cargo.

AN ELECTRO-ENGRAVING PROCESS was invented in 1897 by Josef Rieder, of Munich, but has only recently been perfected. It is intended chiefly to produce steel dies for jewelers, for stamped leather goods, card-board and wall-paper. A porous gypsum model is brought in contact with the plate, and both are dipped in a special solution capable of conducting an electric current. This model has to be raised and cleaned of the carbon refuse every 15 seconds, and special machinery has been devised to perform this work and accurately replace the model.

THE COPPER RANGE R. R. IN THE NORTH MICHIGAN PENINSULA.

This new railway opens up a section of the Michigan copper region known as the South Range, which has not hitherto been worked owing to lack of transportation facilities. The copper region lies in the three counties of Keweenaw, Houghton and Ontonagon, within a strip of land from two to six miles in width. The greatest, and in fact the only extensive development, has been on the island north of the arm of Lake Superior known as Portage Lake. This lake presents a remarkable feature of topography; it receives the waters of the Sturgeon River and other smaller streams, and discharges through Portage River into Keweenaw Bay. Its shore line is irregular in shape, and for a length of eight miles its width is between 600 and 2,000 ft., with hills 500 ft. high on either side, reaching down close to the shore. The north end of this narrow arm originally extended to within two miles of Lake Superior, and the intervening land consisted of a mile of swamp and about the same distance of sand, which latter was about 15 ft. above the lake level. The total width of Keweenaw Point is about 19 miles here, and the opportunity of making a cut-off by canal was early appreciated. Soon after the Civil War a canal was cut through the two miles at the north end of Portage Lake, by a corporation which received a large land grant as its remuneration. Portage Lake is a convenient short cut for vessels touching at Lake Superior points, and is used daily during the season of navigation by a great many steamers and barges. The U. S. Government is now improving the channel by dredging it to a uniform depth of 21 ft., and extending breakwaters at its entrances. With its good depth of water and facilities for unlimited dock room it is one of the best harbors on the lakes.

Fig. 2.—Leveler of Snowshoe Surveying Party; Copper Range R. R.

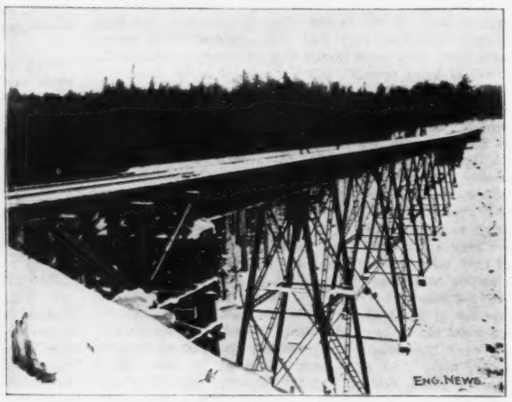


FIG. 3.—STEEL TRESTLE OVER THE EAST BRANCH OF THE FIRESTEEL RIVER; COPPER RANGE R. R.

The great copper mines of this region, the Calumet & Hecla, the Tamarack-Osceola and the Quincy, are located north of Portage Lake, while the only producing mines on the south are the Atlantic and the Baltic. The high price of copper has led to the reopening of several of the old mines in Ontonagon county, and the development of a number of new mines in the region served by the Copper Range R. R., some of which are very promising, and it is said that in all probability the South Range will soon be a thickly-settled mining region.

The copper of the Lake Superior region is found in its pure metallic state; it is not an ore like the Montana and Arizona products. It occurs in veins or lodes from 2 ft. to 40 ft. thick, dipping to the northwest 40 to 70°. Some metallic silver is found with the copper, but the latter metal is the principal source of revenue in all the mines. Masses of pure copper, containing as high as 500 tons weight, have been found in years gone by, and pieces weighing 100 lbs. or more are quite common, but the bulk of the copper comes from small fragments, much of it the size of bird shot. The rock as mined is taken to the stamp mills, which are usually located at some point where there is an abundance of water, and plenty of space for the discharge of the tailings, which are locally known as "stamp sand." The steam stamps pulverize the attached rock, and the copper, in a more or less finely-divided state, is removed to a smelter, where it is melted, and cast into ingots for more convenient handling in shipment. As 30 lbs. of copper to a ton of rock is a large proportion, cheap transportation from the mine to the stamp mill is essential.

The Mineral Range R. R., from Calumet to Hancock, was built as a narrow gage road in 1873, but it was not extended across the lake to Houghton until 1885. The Marquette, Houghton & Ontonagon Ry., now part of the Duluth, South Shore & Atlantic Ry., was built into Houghton in 1883. In 1892 the Milwaukee & Northern Ry., now part of the Chicago, Milwaukee & St. Paul Ry., was extended to Champion, and a few years later its branch from Channing to Ontonagon was completed.

The line of the Copper Range R. R. was originally projected by Mr. C. A. Wright, of Hancock, Mich., who in 1889 had surveys made for a railway from Houghton to Watersmeet, on the Chicago & Northwestern Ry., a distance of 80 miles. Neither the C., M. & St. P. Ry. nor the C. & N. W. Ry. could be induced to lend any assistance to the project, and financial conditions for many years prevented the projectors from raising the necessary funds. In 1899, however, by a combination of railway and mineral land interests, the project was taken up again, and has been carried out by the Copper Range Co., which owns mineral lands as well as the railway. The railway is 41 miles in length, extending from the important mining town of Houghton to Range Junction, on the Ontonagon branch of the Chicago, Milwaukee & St. Paul Ry., about 18 miles south of Ontonagon. The railway has the right to cross Portage Lake, between Houghton and Hancock, by the Mineral Range R. R. bridge, and eventually the line will be extended from Houghton to Calumet and the mines in that vicinity. An extension from Range Junction to Watersmeet, on the Chicago & Northwestern Ry., is also proposed. [illegible] is a general map showing the relation of the Copper Range R. R. and its extension to the other railways of the district.

The officers of the Copper Range R. R. are as follows: President, James H. Seager; Vice-President, Wm. A. Paine; General Manager, T. McKeever (succeeding Mr. C. A. Wright); Secretary and Treasurer, Frederick Stanwood; Chief Engineer, Thomas Appleton. The Assistant Engineers were E. D. Miller, Chas. C. Stowell, H. Cleveldon, H. E. Abbott, C. B. M. Craig, Louis Shaw and C. W. Sanders.

Surveys were commenced in November, 1898, and continued throughout the entire winter, which was a remarkably severe one, even for this extreme northern part of Michigan. As the snow increased in depth the surveying parties worked on snow shoes, and even the transit and level were so shod. A wad of burlap was tied around each leg of the tripod, just above the points, or else a tomato can was secured around it so as to prevent the leg sinking down in the snow, for if the instrument was set on the ground the operator could not see out over the snow. Fig. 2 shows a levelman at work on this survey. Transit hubs were set in the ground after digging a well hole in the snow, with a 6-ft. guard stake alongside of it. The rod readings were always taken to the ground with the help of a sounding rod. The parties camped out in tents during the entire work and with plenty of firewood kept themselves comfortable, although the thermometer ran down to 45° below zero in February. The most difficult parts of the location were between Houghton and Atlantic, where a rise of 650 ft. from the lake is encountered, and in the valley of the Firesteel River, near the southern end of the line. Three branches of that river are crossed within a distance of 2,500 ft., in ravines from 65 to 85 ft. deep. The bridges across these ravines are steel trestles with spans alternating 30 and 60 ft., and the total length of the three steel trestles is 1,290 ft., with temporary pile approaches which will eventually be filled with earth. Fig. 3 shows the steel trestle over the east branch. There are also three timber trestles on other parts of the line, ranging from 55 to 85 ft. in height, which will be filled with earth when the timber becomes weakened by decay. Two views of the 85-ft. trestle are shown in Figs. 4 and 5. From these it will be seen that the trestle is not only of substantial construction, but that it is provided with an exceptional amount of longitudinal bracing, both horizontal and diagonal. This is a commendable feature, as many trestles are built with but a limited amount of such bracing. The steel trestles were designed by Mr. Robert A. Shaller, Consulting Engineer, and were constructed by the Phoenix Bridge Co., of Philadelphia, Pa.

Fig. 4.—General View of Trestle.

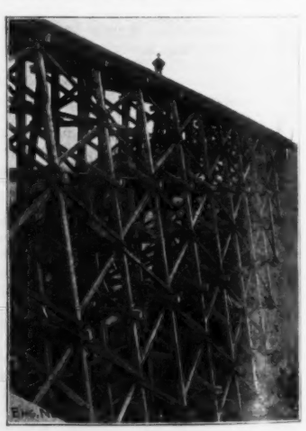


Fig. 5.—Detail View of Trestle.

TIMBER TRESTLE, 35 FT. HIGH; COPPER RANGE R. R.
Thomas Appleton, M. Am. Soc. C. E., Chief Engineer.

The maximum grade is 2%, compensated for curvature. This grade is used in making the rise from Portage Lake to the range, which is generally at an elevation of 650 ft. above the lake. On the

remainder of the line, 1% is the maximum. The sharpest curve on the main line is 6°, and the total amount of curvature is considerable, owing to the mountainous character of the country passed over. Many of the streams are crossed near their heads, so that a small amount of bridging is required.

The general contract for grading, timber bridging and tracklaying was awarded to C. E. Loss & Co., of Chicago, in April; and actual work commenced in May, 1899. Owing to the large amount of quarry and mining work going on the contractors experienced great difficulty in getting sufficient men, and as the summer was a very wet season the roads were very bad for hauling in supplies, so that the grading was only about two-thirds completed at the close of the year. Nevertheless, the track was laid through and a train run from one end of the road to the other on Dec. 27, and the line has been in regular daily operation ever since.

For the greater part of the distance the line runs through a sand and gravel country, with about five miles of clay at the south end of the line. The country is heavily timbered, and the 100-ft. right of way was cleared by burning, owing to lack of facilities for transporting the timber to Houghton. The contract called for 1,020,000 cu. yds. of excavation, of which 700,000 cu. yds. were completed by the end of 1899. The wages paid by the contractors at first were $2 per day for laborers, and $4.50 per day for teams, but these rates were increased to $2.25 and $5 per day, respectively. About 500 men and 200 teams were at work all the summer. A considerable part of the grading was sublet by C. E. Loss & Co. The contract for the terminal yard at Houghton and for grading the first section of the line, 1¾ miles, was sublet to John C. Lee, of Chicago. The other subcontractors for grading were as follows: Northern Engineering Co., Toledo, O.; M. R. McGee, Chippewa Falls, Wis.; J. W. Gill, of Chicago; R. R. Clason, of Ishpeming, Mich.; Louis Mathison, of Chicago; Davis & Davis, of Duluth; Ford & Malloy, of Chicago; Smith, Henderson & Co., of Detroit, Mich.; Charles C. Heughens, of Lake Linden, Mich.; Powell & Laterell, of Marquette, Mich. The ordinary excavation was done by wheelbarrows and scrapers, and small dump cars. The trestles, small bridges and culverts were sublet to A. F. Gillis, of Menominee, Mich.

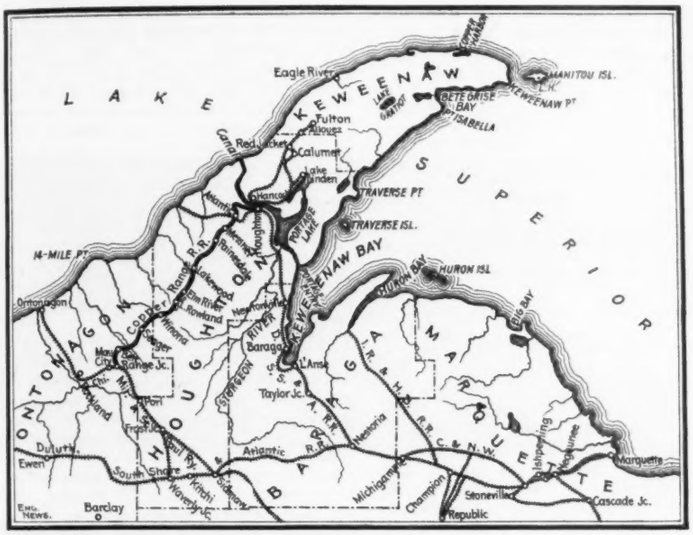


FIG. 1.—MAP OF THE COPPER RANGE R. R. AND ITS CONNECTIONS.
Thomas Appleton, M. Am. Soc. C. E., Chief Engineer.

The track was laid by a Holman machine. The rough unfinished condition of the grade did not afford any opportunities for record-breaking speed in tracklaying, as the track gang was continually driving the graders out of the cuts. The greatest day's work was 7,200 ft. of track laid. The line is laid with 75-lb. steel rails of the Am. Soc. C. E. section, rolled by the Illinois Steel Co. They are laid with square suspended joints, spliced with six-bolt angle bars, 30 ins. long, the bolts being spaced, 4, 5 and 6 ins., c. to c. The ties are of hemlock, cedar, tamarack and oak, spaced 24 ins. c. to c. Tie-plates of the Q. & W. pattern are used on the curves. The line is only partially ballasted at present, but will be ballasted throughout with gravel not less than 6 ins. deep under the ties. Split switches and No. 10 rigid-bolted frogs are used on the main line.

The terminal yard at Houghton has a water front half a mile long, with 1,000 ft. of crib dock completed. The main channel at this point has 50 ft. of water and a solid rock bottom. At the dock the depth is 25 ft. The front of the dock is a crib-work of hemlock timber filled with rock, and anchored to the shore by heavy wire cables. Pile driving was impossible, as the bottom is bare rock. The dock was built by the Shailer & Schniglau Co., of Chicago. As business requires, the dock will be extended and additional tracks laid in the yard, so that excellent facilities for "lake and rail" business will be afforded. During the season of navigation, generally from May 1 to Dec. 1, a great deal of freight is handled here by the numerous steamboat lines which pass through the lake.

The most pretentious station is that at Houghton, which is a two-story structure, 32 × 84 ft. In plan, built of mottled pressed brick, trimmed with Portage red sandstone, and having a metal tile roof. The second story contains the offices of the railway company, and the ground floor has two waiting rooms, baggage room and ticket office. The station was built by Prendergast & Clarkson, of Chicago. A frame freight house, 50 × 150 ft., is to be built on the dock, and frame station buildings, 24 × 62 ft., will be constructed at the intermediate stations. There will also be a new union station at Range Junction. Seven section houses, for the section gangs to live in, have been constructed.

These are frame buildings, 24 × 30 ft., two stories high. At Houghton there is a ten-stall brick roundhouse (four stalls being fitted up for a machine shop), a brick storehouse, 40 × 80 ft.; a 64-ft. steel turntable, and an ashpit with depressed track. The roundhouse has stalls 72 ft. long, and is heated by steam coils in the pits. The machine shop contains a 25-HP. Ide engine, a 42-in. lathe, a smaller lathe, planer, drill press, emery wheel, etc., and an 800-gallon fire pump, which also supplies the water tank. The stations are as follows:

	Miles.		Miles.
Houghton	....	Lake Rowland	24.1
Atlantic	5.1	Winona	27.1
Messner	8.2	Seager	31.3
Painesdale	11.6	Belt	38.1
Lakewood	17.4	Range Junction	40.9
Elm River	21.6		

There are four water stations, built by the Otto Gas Engine Works of Chicago; three of the tanks are 24 ft. diameter and the other 18 ft. All have 16-ft. staves. Three of them are supplied by 20-ft. Halliday windmills and 4 × 12-in. Curtis pumps.

The equipment includes 9 locomotives, 4 passenger cars, 2 smoking cars, 2 baggage cars, 100 flat cars and 50 box cars. The freight cars are of 60,000 lbs. capacity. All the cars were built by the Pullman Car Co., of Chicago, and are equipped with Westinghouse brakes and Janney couplers. The passenger trains are heated by steam from the locomotive. The locomotives were built by the Baldwin Locomotive Works, and are as follows: Three consolidation freight engines, weighing 157,000 lbs. (exclusive of tender), with cylinders 21 × 28 ins.; two ten-wheel passenger engines, weighing 133,000 lbs., with cylinders 19 × 26 ins.; three eight-wheel engines, weighing 84,000 lbs., with cylinders 17 × 24 ins., and a six-wheel switching engine, weighing 111,000 lbs., with cylinders 19 × 26 ins.

Although built through an undeveloped tract of woods the road is already doing a remunerative business, and is believed to have excellent prospects.

SELF-PROPELLING HYDRAULIC DREDGE FOR THE MISSISSIPPI RIVER.

(With two-page plate.)

The development of suction or hydraulic dredges of large capacity is one of the important and interesting features of the dredging work for the maintenance of navigation on the Mississippi River, and in our issue of Oct. 13, 1898, we published an interesting article on "Dredges and Dredging on the Mississippi River," by Mr. J. A. Ockerson, M. Am. Soc. C. E. Most of these dredges are not equipped with propelling machinery and have therefore to be handled by steam tenders or tow boats, of the type described and illustrated in our issue of Dec. 7, 1899. The largest of the non-propelling hydraulic dredges was described and illustrated in our issue of July 22, 1897.

The latest phase of the development of the dredges is the application of propelling machinery, so as to avoid the necessity of using tenders to handle the dredge. One dredge of this class, to be called the "Iota," is now being built for the Mississippi River Commission, and will be a steel-hulled vessel fitted with side wheels, as shown in the longitudinal section and main deck plan, Figs. 1 and 2. The general dimensions are as follows:

	Ft.
Length, molded	192
Width, molded	44
Depth, molded	7
Draft	4
Width at bow	32
Width at stern	34
Width over guards, outside of nosing	70
Length of well	33
Width of well at nose	25

Capt. Mason M. Patrick, U. S. Engineers, Secretary of the Commission, informs us that Mr. Thomas Middleton, Assistant Engineer, has had charge of the designing of the dredge and of preparing the detail drawings, and deserves great credit for the modifications which have been introduced in this vessel. At his request, Mr. Middleton has furnished us with a description of the dredge, which we give below, as follows:

The dredge "Iota," now under contract for the Mississippi River Commission, is designed on the same general lines as the last two dredges acquired, the "Epsilon" and "Zeta" (Eng. News, Oct. 13, 1898), so far as the pumping machinery is concerned, but embraces a radical departure from all other dredges which have been built for the Commission, in that it is self-propelling, thereby dispensing with the usual large tow boat and its attendant expenses.

The "Iota" is 192 ft. long, 44 ft. beam; 70 ft. wide over guards and 7 ft. deep, with a draft of 4 ft. in working trim. The hull is entirely of steel; framed transversely; and divided into watertight compartments by six transverse bulkheads and two collision bulkheads in the wings forming the well. It is strengthened longitudinally by four truss frames in the form of latticed girders, as indicated in Fig. 4. All the machinery is carried on the deck of the dredge, and local strength is obtained by extra truss frames, stanchions and gusset bracing, as required by prevailing conditions.

The sand pumping machinery consists of a 32-in. centrifugal pump, which has a five-bladed runner 75 ins. diameter, and is driven by a pair of horizontal, tandem, compound, condensing engines with cylinders 16 and 26 ins. diameter and 20 ins. stroke. The discharge pipe is located as near the bottom of the boat as possible and is riveted to each bulkhead, being thereby incorporated in

the hull structure. At the point of issuance through the stern, the discharge pipe is fitted with a swivel elbow (Fig. 3) which admits of the floating pipes being turned at right angles to dredge on either side, and is intended more particularly for depositing material outside of the channel, when a short length of discharge pipe is used.

The floating pipe is carried on pontoons made as shown in Fig. 4, each pontoon bearing 50 ft. of pipe, and two lengths of pipe being rigidly connected together by flanges making sections 100 ft. long supported on two pontoons. These again are coupled together by flexible joints of rubber hose and coupling bars. Each length of pipe is secured to a pair of carriages which revolve on a circle 12 ft. in diameter, secured to the deck of the pontoon, thus permitting the pontoon to swing with the flow of the stream, regardless of the position of the discharge pipe. To secure the pipe to the pontoon, when desired, a locking device is attached to each carriage, and a pair of chains with turnbuckles is also provided to fasten the pipe in a fo e and aft pos.tion while being towed. In order that the swinging motion of the pontoon may be assured, a tail fin is provided and is hung from the stern post and secured by wire rope guys; behind this fin a small rudder is placed to assist in swinging the pipe line. As it is often necessary to swing the pipe line a considerable distance from the axis of the channel, advantage is taken of the force of the current, and by placing the pontoons at the required angle, on the principle of the flying ferry, a considerable amount of deflection can be obtained. A further notable feature in this connection is the reaction or baffle plate at end of discharge pipe (Fig. 5), which is made movable and is controlled by wire rope lines connected to a small capstan on the pipe. By turning this plate to give an excess of delivery on one side, the force of the issuing water is utilized to assist in deflecting the pipe lines. By this means it is frequently possible to dispense with the sinking of piles, as ordinarily used, for deflecting the pipe line to a point necessary for depositing the spoil of dredging outside of the navigable channel.

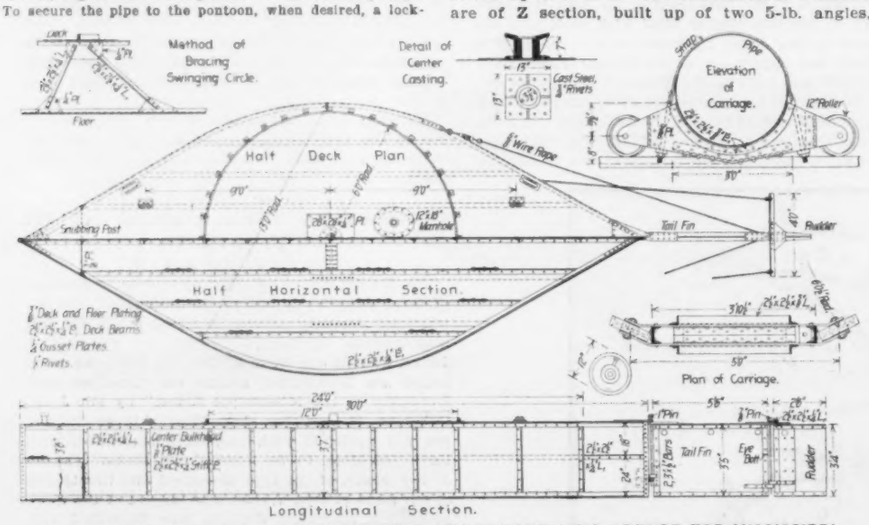


FIG. 4.—PONTOONS FOR DISCHARGE PIPE, SELF-PROPELLING DREDGE FOR MISSISSIPPI RIVER.

The method of loosening or agitating the sand in front of the suction heads is by water jets, so successfully adopted in several of the other dredges belonging to the Commission. In the case of the "Iota," however, the high pressure system has been followed, similar to that in use by Major Thomas H. Handbury, U. S. Engineers, on dredges designed and illustrated in Engineering News, July 22, 1897. For this purpose a compound, duplex, plunger pump is provided, having steam cylinders 12 and 20 ins. diameter, and 16-in. water cylinders, all of 15 ins. stroke, capable of delivering 2,000 gallons of water per minute through 1-in. nozzles at a pressure of 120 lbs. per sq. in. The steam connections are so arranged that direct steam can be admitted to the low pressure cylinders when hard and compact material is encountered, requiring the full capacity of the pump to dislodge and break it up. For the sand ordinarily met with in newly formed bars a pressure of 20 lbs. per sq. in. is found to be sufficient.

The dredge will be propelled by side paddle wheels 21 ft. diameter over the buckets, driven by independent engines of the type in general use on the Mississippi River. The cylinders are 22 ins. diameter and 6 ft. stroke, fitted with balanced poppet valves and variable cut-off, but the old style wooden pitmans will be replaced by a more modern type, built up with solid stub ends and steel tube centers, truss rods being used to give the required stiffness. These engines were built by the Frisbie Engine & Machine Co., of Cincinnati, O.

This dredge is fitted out in a thorough manner with all modern conveniences, including an electric light plant, steam steering gear, a machine shop with outfit of first-class machine and small tools, hot and cold water service to all baths and washroom, steam heating in cabins, etc. There will also be a refrigerating plant having a capacity of two tons of ice per day, which will cool the storage room and make the ice required for domestic purposes.

The general drawings Figs. 1 and 2 are not very complete with regard to the details of machinery, owing to the fact that the particular make of engine or machine was left to the selection of intending bidders, subject to conditions and approval, and it was not until after the contract was awarded that the Commission was in possession of detailed drawings of the specific machines with which the dredge is to be finally fitted.

There are 128 main transverse frames, spaced 18 ins. apart c. to c. The even numbered frames are of Z section, built up of two 5-lb. angles, $2\frac{1}{2} \times 2\frac{1}{2}$ ins., and a plate 3-16×8 ins.; to the top edges of these are riveted reverse frames of angle irons of the same size, extending up the bilge to a vertical height of 30 ins. from the bottom. The odd-numbered frames are of 5.5-lb. angles, $3 \times 2\frac{1}{2}$ ins. The deck beams consist of these latter angle irons and 15.6-lb. Z-bars, 6×6 ins., placed alternately. The gunwales are of 7.2-lb. angle irons, 3×3 ins. The hull and deck plating will be similar to that of the steam tenders above described, except that in the deck only the plate sheers will be of 12.75-lb. plate. The deck will be level throughout, without crown or sheer.

The two collision bulkheads are at frame No. 10, in the wings forming the well for the suction pipe. The other bulkheads are all in the main part of the hull. They are all to be watertight, and of the same construction as in the steam tenders. The inside plating of the well will extend back under the deck from frame No. 22 to frame No. 32, and from the bulkhead at that point the four longitudinal latticed trusses will extend aft to the stern. The inboard and outboard trusses on each side are 5 ft. 6 ins. and 14 ft. from the center line, and their construction is the same as in the steam tenders. The specifications for material and the test for the hull are also practically the same.

The guards will be supported by gusset plate outriggers at the ends, and elsewhere the outriggers will be composed of angles and plates. Across the end of the well will be a box girder, 36×36 ins., with projecting plates along the front to carry the vertical screen bars. These bars are of extra heavy 3-in. pipe, 4 ft. long, held in place by ¾-in. pins at the top. Along the upper edge of this girder is an oak nosing timber, 8×6 ins. The cylinder beams will be heavy plate girders. Near the bow will be a spud well in the hull, 23½ ins. square inside, for a timber spud 22×22 ins. The suction heads will be suspended from a hoisting frame built up of two A-frames, connected at their heads. Each leg will consist of two 9-in., 14-lb. channels, connected by lattice bars. A pair of sheer legs will be fitted at the stern for lifting the swivel elbow and rubber hose connections.

The vessel will have two balanced rudde[rs] 24 ft. long, 4½ ft. deep, and 18 ft. apart, built [in] the same way as those of the steam tenders.

The deck house will extend from within [a] ft. 9 ins. of the well to within 16 ft. 6 ins. of the [st]n, and will be 44 ft. wide for the most part. A[ll] the boilers and machinery will be on the main [de]k, and the living quarters will be on the up[per] or boiler deck. This deck will have a cabin 1[00] ft. long and 34 ft. wide. Two passages will [di]vide it into three sections; the forward section [wi]ll contain 13 staterooms, bathroom and store[ro]m, all 10 ft. wide, with office and mess room bet[we]n, 14 ft. wide. The intermediate section will co[nt]ain the kitchen, pantry, laundry, washrooms, b[at]hrooms, etc. The after section will contai[n] the mess room, two bathrooms, and sleeping qu[ar]ters for the crew, cooks and waiters. Above the [af]ward end of the cabin will be a pilot house 1[0] ft. square and 10 ft. high.

Each suction head will have a flaring mou[th]-piece, 11 ft. 6 ins. wide and 8½ ins. deep at the smallest part, and fitted with cast-iron screen bars 8 ins. apart. Diagonal tension rods and a coupling bar will be fitted between the two suction heads. The radial joints will have cast-iron radial pipes, machined all over, and cast-steel hinge pieces. The inside pipes are to be of cast iron, bolted to the bow hinge pieces, which will change in form from square to round, and be connected to the suction pipe of the pump by short pieces of 8-ply rubber hose. The 32-in. discharge pipe in the hold will be made of 10.2-lb. plate, with angle iron flanges riveted to the bulkheads and forming part of the hull structure. The swivel elbow for the discharge pipe, Fig. 3, will consist of two 32-in. cast-steel elbows coupled together by a collar flange working in a recess, and held in place by a ring and bolt. Two forged eye-bars, backed with 5-in. T-bars, are to be supplied for coupling the pipe lines to the dredge.

The pipe line will consist of ten lengths of 32-in. pipe, each 50 ft. long, built up of ¼-in. steel plate, with lap joints. One end (for the hose) will have a bead of half-oval iron, and the other a cast-steel flange riveted on, and faced, so that the pipes can be coupled together in 100-ft. lengths and the joints made without gaskets. Each length of pipe will be mounted on a pontoon, Fig. 4, 30 ft. long, 15 ft. wide and 3 ft. 6 ins. deep, with a crown of 1 in. for the deck. These will be built of 3-16-in. steel plate.

There will be 20 hydraulic piles, 11 ins. diameter and 35 ft. long, similar to those shown in our issue of July 22, 1897.

The pumping and propelling engines have been described above. Steam will be supplied by seven boilers 3 ft. 8 ins. diameter and 30 ft. long, built for a pressure of 170 lbs. per sq. in. Each boiler will have four 11-in. flues of lap-welded tubes. The shells will be of marine steel, of 60,000 to 65,000 lbs. tensile strength, 0.31-in. thick, with longitudinal seams above the fire line and double riveted. Each battery will have a 30-in. steam drum and two 16-in. mud drums. The boilers will be built in with brick. There will be two smokestacks 3 ft. 6 ins. diameter, with their tops 70 ft. above the grates. The auxiliary boiler will be of the vertical, submerged tube type, 42 ins. diameter and 9 ft. high. The boilers, steam drums and steam pipes will be covered with magnesia. Two horizontal duplex pumps, with outside packed plungers, 5×10 ins., and each having a capacity of 80 gallons per minute, will supply water for feed and fire purposes. The electric light plant will consist of a 110-volt multipolar dynamo, direct coupled to a vertical engine, supplying current for two 18-in. searchlights of 4,000 c. p., two arc lights of 1,200 c. p., and about 100 incandescent lights.

As the dredge itself is not yet far enough advanced to permit a photograph of the completed vessel to be made, we show in Fig. 6 a photograph of a model of the vessel which was made for the Paris Exposition. It will be seen that the model is supported on a sheet of glass representing the water surface, and the working parts beneath the water are shown, together with the outlet pipe, pontoons, and pile-driving tender.

The contract for this dredge was awarded in July, 1898, to the Springfield Boiler & Mfg. Co., of

...ld, Ill. The tests to be made are described ... in the official specifications.

...tor's Test.—This will consist in running the main ... and pump at a velocity of 175 revolutions per ... during a continuous period of ten hours while ... water through 500 ft. of discharge pipe, the ...chinery being run at the same time at its full ...peed. Before this test, the dredge will be moved ...oint in the river near Cairo, Ill., as the Engineer ... charge may select, and will remain anchored ...ud during test. This test must be run at the ...nse of the contractor. During the test, full ... of the running of all machinery will be taken by ...horized agents of the Engineer Officer in charge, ... contractor will have full control of the working ... machinery. Should this test not be successful, ...ts on the same plan must be made until the ma... will satisfactorily perform the requirements.

...ment Test.—When the contractor's test is suc... completed, the Government efficiency test will be ... under the direction of the Engineer Officer in charge, ... own employees. This test will consist in operat... the dredge under actual working conditions, with the ... engines and pump running at about 160 revolutions ... minute, and all the other machinery at the requisite ... capacity, for a period of five days, either con... night and day or for any less period, at the ... of the Engineer Officer in charge. During this test ... line may be increased to 1,000 ft. and capacity ... taken, and the dredge manoeuvred in any way the ... Officer in charge may deem advisable, but the main engines will not be run above 165 revolutions, the steam pressure carried will not exceed 170 lbs. per sq. in., and the dredge will not be forced into the cut beyond a fair working speed according to the face of bank ahead. Full records of this test will be taken and the time of stoppages for repairs due to defective material or bad workmanship must not exceed 15% of the time spent in actual dredging. Any minor repairs needed during this test which can be done on board will be done at the expense of the United States, but the cost of all other repairs must be borne by the contractor. During the Government test the contractor and his authorized representatives will be taken care of aboard the dredge, but will not be allowed to give any orders to any of the crew without the consent of the agent of the United States in charge.

Towing Test.—To test the working of the propelling engines, the dredge will make a trip of four hours duration upstream, and return, with one pile sinker, one coal barge partially loaded, and all the pipe line in tow. The engines will be run full speed with various rates of cut-off, and full records taken.

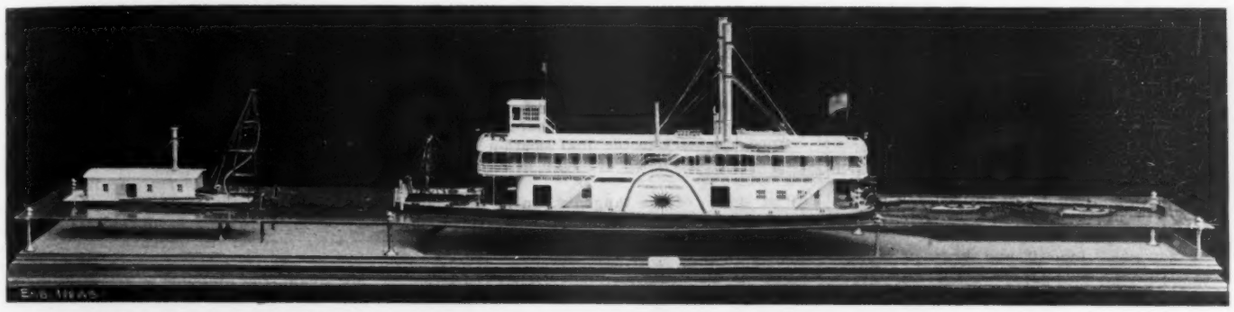


FIG. 6.—MODEL OF DREDGE "IOTA," WITH PONTOONS AND FLOATING PILE DRIVER, MADE FOR THE PARIS EXPOSITION.

THE PRELIMINARY ALINEMENT OF THE NEW CROTON AQUEDUCT.

By E. Sherman Gould, M. Am. Soc. C. E.*

When the building of the New Croton Aqueduct was undertaken, the City of New York was as unprepared for the carrying out of such a gigantic piece of work, as the United States was for a foreign war at the commencement of hostilities with Spain. But in both cases there was a long bank account to draw upon, so that eventually all that was attempted was successfully accomplished. The full history of the New Croton Aqueduct will never be written, nor is it at all necessary or even desirable that it should be. Suffice it to say that it made and unmade several promising careers, and resulting in enriching the City of New York with a fine and much-needed piece of engineering work.

Considered in this latter light, a close study of the design and execution of the New Croton Aqueduct is of the highest possible professional interest. This study is made possible through the two magnificent volumes of reports, published by the Aqueduct Commission. But there are many minor details of which these reports could not take cognizance, which still possess sufficient interest to warrant a description. It has occurred to the writer, therefore, that in continuation of a previous paper,* it might be useful to record in these columns the details of some of the preliminary instrumental work connected with the location of the center line of the New Croton Aqueduct.

This preliminary work was done by engineers of the Croton Aqueduct Bureau, under the direction of the late Isaac Newton, then Chief Engineer of the Croton Aqueduct, and was subsequently turned over to Mr. B. S. Church, the Chief Engineer of the Aqueduct Commission. The question of the degree of accuracy with which the preliminary line should be run came up at an early date. The object of the survey was to obtain data for the preparation of maps showing the alinement and profile of the aqueduct, and also of property maps for securing the necessary right of way, easements, etc. It was decided that the tangents should be run upon as mathematically straight and accurate lines as was possible with the ordinary engineer's transit, and 50-ft. steel tape, so as not only to fulfil the above requirements, but also, if possible, establish the alinement with sufficient accuracy for construction.

The work was divided into several sections; all that follows refers to that section which extended from about a mile below Ardsley, south to or about the line of the City of New York. The headquarters of this section were at the Yonkers office of the old Croton Aqueduct, and the survey was in charge of the writer.

A line having been run through with somewhat more than the degree of care usually exercised in a good railroad location, it was tested by running back a second similar one, over the same ground. The two were found to differ to such a degree as to fall short of the desired accuracy. Measures were therefore taken to rerun the line, using entirely exceptional methods to secure the unusual degree of precision deemed essential These methods were left entirely to the discretion of the engineer in charge. Two sighting poles were provided, of octagonal steel, perfectly true, about 5 or 6 ft. long, and, perhaps, 7-16-in. in diameter. These were placed in a lathe, and a sharp point turned at one end exactly in the axis of the rod. This point was protected by a cork when not in use. A number of locust posts were provided for plugs, some 2 or 2½ ft. long and 4 ins. square, sharpened at one end. As the work was done in midwinter, and a very severe one at that, picks and bars were frequently necessary to open the ground for driving these plugs.

To describe the process employed let us now suppose that two plugs have been placed, and the transit set up over the forward one for the purpose of producing the line still further. As high winds prevailed it was often very difficult to center the instrument accurately over the small tack set in the plug. A screen made of two boards placed at right angles to each other was useful, but all hands were sometimes called up to form a "lee" for the plumb line, by standing to windward of it. The distances between plugs were small. It was made a sine qua non that the transitman should be able to see down to the very point of at least one of the sighting poles, either on the back or foresight, and within a foot or two of that of the other. It was considered preferable to take two or three comparatively short but exact sights, rather than a much longer one, where only the upper foot or two of the poles could be seen. It was also deemed essential that the pole should be sufficiently near not to be entirely covered by the vertical hair of the transit, but to show a portion on each side of it, or at least not to more than cover it, so as to ensure bisection. Writing from recollection, I should say that the sight under these conditions never exceeded 300 ft.; that is to say, that the plugs were seldom or never more than that distance apart.

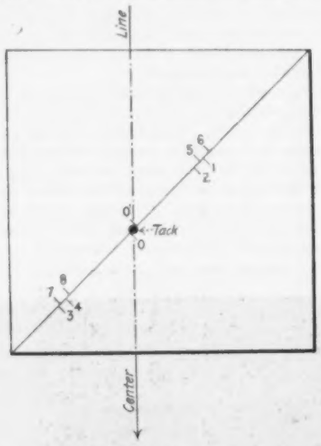
There were two transitmen employed, who took turns in setting up the instrument and taking the first set of sights. Transitman No. 1, having set up, took a backsight, turned over the telescope and gave line for the plug, watching it as it was being driven, so as to keep its center as nearly as possible on the line. Care was taken to drive it at least approximately square with the line. When it was driven well home, a straight line was marked across the head with a pencil, diagonally from corner to corner, as shown in the figure, where the upper side of the plug is supposed to be facing the transit. When all was ready, the transitman carefully took his backsight, quickly reversed his telescope and set the point marked 1 in the figure. In setting this point, which was merely marked on the plug with a pencil, the sighting rod was moved from side to side along the diagonal line. The object of this was to increase the amplitude of the movement, and exaggerate the distance, at right angles to the line, separating the points. Having marked the point, 1, the rod was removed, and the transitman, without unclamping the instrument, proceeded to renew his backsight and take the same foresight over again. Theoretically he ought to set the point in exactly the same place as before; practically he never did, except by accident. If, however, the two differed widely, it would be considered that one or both were defective, and this sight would be repeated. An agreement within ⅛-in. or 3-16-in. would be acceptable. These two points being satisfactorily established, he would unclamp, and revolve his plates 180°, so that if on the previous sight the north side of the compass box was ahead, the south side would now lead. The line of collimation being always (preferably) a little out of adjustment, he would now strike, say, No. 3. If the mark should fall off of the plug it would have to be taken up, or another one driven more nearly on line. The transitman would repeat this sight also, striking, perhaps, at No. 4. The distance between Nos. 3 and 4 should be nearly equal to that between 1 and 2, or it would be inferred that the work was of doubtful quality. Generally the discrepancies were quite near to each other.

Transitman No. 2 would then take his place at the instrument and repeat the same process, his marks being made on the opposite side of the line. They are shown on the figure by the numbers 5, 6, 7 and 8. This group would also be studied carefully for acceptance or rejection. If the two were found to be fairly consistent with themselves, each

*Yonkers, N. Y.

*Hints upon Transit Surveys: Engr. News, Jan. 4, 1900.

to each, their consistency with each other would be tested. For this the distance from center to center of 1—2 and 3—4 would be bisected, and the mark, 0, made. This represents the true line according to transitman No. 1. Operating in the same way, the center, 0′, according to transitman No. 2, would be found. If agreeing within, say, ⅛-in., the tack would be driven midway between 0 and 0′. Sometimes the agreement was not satisfactory. Then the head of the plug would be scraped clean, a fresh diagonal drawn between opposite corners, and the whole series of sights would be repeated. If they still failed to agree sufficiently close, the engineer in charge would



Head of Plug Used in Surveying Center Line of New Croton Aqueduct, Showing Method of Locating Point on Line.

(One-half scale.)

take the instrument himself, and throw off rapidly a series of sights. If he agreed closely with either of the two his sights would be averaged with those of the latter and the tack set. Sometimes, on very windy days, even after repeated trials, no sufficiently close agreement could be had. Work would then be stopped for that day, as a single careless or uncertain station would vitiate the whole line.

It will be easily seen that the work thus prosecuted necessarily went on very slowly. What with setting up, picking out a hole in the frozen ground and driving the plug, and getting the two transitmen to agree on a modus vivendi, it would, on an average, probably take from an hour to an hour and a-half to set each tack. When the alinement was thus established, it was chained over, and 100-ft. stations set. These were lined in by the transit, from plug to plug, with ordinary care, and the measurements made with a 50-ft. steel tape, with spring balance and level in one handle, and also a temperature adjustment worked by a screw. Measurements were made between plumb bobs, the chain being held clear of the ground. An observer would watch the hind plumb bob, and when it was vertical, motionless and directly over the mark, he would call "Now!" His duties were to simply watch and call whenever the plumb bob was as above described. Another observer would watch the forward plumb bob, and when it was stationary, at the exact moment when the rear observer called "Now!" he would make a mark. This mark would then be verified, and if not found correct the operation would be repeated until it was so. According to recollection, 1,000 or 1,500 ft. was not a bad day's work. The chaining was even more tedious than the alinement, and the strain on the engineer in charge, who personally marked the distances, was greater.

The next process was to locate all road and stream crossings, and all fences, whether property lines or no. This was done by the tape line alone, and the notes kept in an ordinary blank book, with a column about ¾-in. wide, ruled down the center of the page. The stations and "plusses," from which points were triangulated with the tape, were marked in this column, and the tape measurements marked on each side, according to a sketch made in the usual way, when this system is employed. Afterwards, when the width of right of way was decided upon (33 ft. on each side of center line), more careful measurements of property lines were made. When a fence line was reached which it was desired to locate, the point at which it crossed the center line was carefully measured. The transit was set up over the nearest station centered for the purpose, a right angle turned off, and 33 ft. measured out. This transferred the exact distance on the center line to the side line, along which the distance at which the latter crossed the fence was accurately measured. The same was done on the other side of the center line, so that the three points at which the center and two side lines cut the fence were accurately determined.

From these data, the maps showing the alinement and property lines were prepared and filed, and a grand struggle it was, too, to get them completed in time to fulfil statute requirements. The whole business was then turned over to the Aqueduct Commission, and subsequently the whole line, comprising all the separate sections, was rerun and permanently monumented, in the only way in which the necessary accuracy could be secured, namely, by the erection of lofty and widely-separated observatories, in which special line instruments were set up, and from which commanding positions, long stretches of line, previously crawled over, a few feet at a time, were cut in with one sweep of the powerful telescope employed.

The practical outcome of the preliminary work just described, was this: a vast amount of valuable time was consumed in establishing a line, far exceeding in accuracy what was required for the purpose of preparing land maps, but which did not quite attain the full measure of perfection deemed necessary to the final location of the center line of the tunnel, although nearly approaching it.

The length of the tangents run in the manner just described, with their bearings, as measured with same transit used in the alinement, were as follows:

N. 22° 43′ 45″ E.	5,800.970	ft.
N. 17° 10′ 37.5″ E.	8,615.460	"
N. 19° 30′ 18.75″ E.	4,008.975	"
N. 14° 33′ 0.0″ E.	3,946.365	"
N. 27° 12′ 3.75″ E.	7,450.460	"
N. 34° 52′ 15.75″ E.	205.250	"
	30,027.480	ft.

I regret that I did not secure and record at the time the exact variations in alinement and measurements between the preliminary line and the final one, but when construction commenced the more important considerations involved relegated the mere surveying part of the work to the domain of ancient history. The agreement, however, I know was very close; I believe the greatest variation found to exist when the tangents were cut in from end to end was about 0.10 ft., or possibly 2 ins. It appears to me that the results show that the finest work done with a 5-in. needle transit in running a straight line of, say, one mile in length over broken ground, can only succeed in tracing a curve having a versed sine of 0.10-ft.; or to express it differently, the best that can be done under the given conditions is to run a curve of a radius of about 4,000 miles, or, say, the semi-diameter of our planet.

The changes of direction in the tunnel occurred almost invariably at the shafts. It has always appeared to the writer that it would be preferable to locate them, when the ground permitted, as near midway between shafts as possible. In this position, nothing more than ordinary care would be required in establishing the line under ground, because the lines must intersect somewhere, and the exact point of intersection would be a matter of indifference.

GARBAGE REDUCTION AT CLEVELAND, O.

A contract for the collection and disposal of the garbage of Cleveland was awarded in December, 1897, to the Buckeye Refuse Destruction Co. The contract runs for five years from the date the reduction works were put in operation, Aug. 22, 1898. The city agreed to pay $69,400 a year, in monthly installments, for the service. Early in 1898 the contract, for disposal at least, was sublet to the Newburgh Reduction Co. It is said that many of the members of both companies were identical, and that the sub-contractor had a reduction plant for dead animals already in operation. This plant was remodeled by Mr. E. S. Peck, Superintendent of the company, under patents claimed by the Detroit Sanitary W[illegible], of Detroit, Mich. The works are located at [illegible]low, O., a few miles outside the city limits.

The city has an area of about 32 square miles. Its population, in 1898, when the plant was put in operation, was estimated at approximately 400,000. The collections are made three times a week inside the three-mile circle, and twice a week outside, but from hotels and boarding-houses daily collections are made.

The garbage is shipped by rail from the city to the reduction plant, a distance of about nine miles. It is collected in detachable steel wagon boxes, or boxes, of which 120 were in use in October, 1898, and 250 in March, 1900. Part of the wagon boxes were made by J. T. Whitehead & Co., of Detroit, and the balance by the Van Dorn Iron Works, of Cleveland. The wagons were made by W. H. Gabriel & Son, of Cleveland.

The loaded wagon boxes are hoisted off the wagons at the railway station and loaded onto cars. The boxes are placed crosswise of the cars, originally in two tiers of seven each, making 14 per car, but cars designed to carry three tiers of eight boxes each, or 24 in all, are now in use. The company owns ten of the new style of cars, built by the Michigan Peninsular Car Co., of Detroit. The cars were bought for this particular work. We are informed by their manufacturers that they are simple flat cars, with open racks.

The garbage boxes are lifted from the cars at the works by an electric traveling crane, built by the Brown Hoisting & Conveying Machine Co., of Cleveland, O., and are dumped on an upper floor of the building. A view of this crane in service is shown by Fig. 1. Four of the eight wheels used to suspend the crane from the I-beam are driven. It has swivel trucks for rounding curves and a separate motor for vertical and horizontal travel, respectively.

After sorting, the garbage is dumped into any one of ten vertical digesters, where it is cooked by steam, the pressure in the digesters being 80 lbs. The digesters are fitted with deodorizers of the jet-condenser type, made by the V. D. Anderson Co., of Cleveland. Besides the ten digesters used to treat the garbage, two others are employed to render dead animals.

When the plant was first put in operation, no provision was made for pressing the cooked garbage, except the steam pressure in the digesters, and the garbage was wheeled by hand from the digesters to the dryers. Since then two conveyors

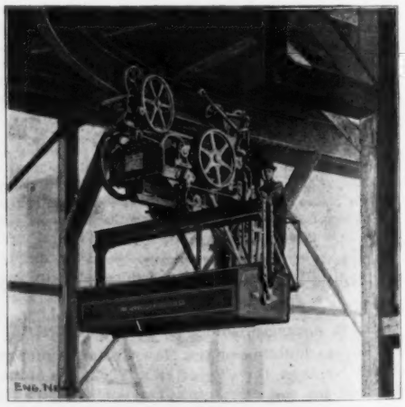


Fig. 1.—View of Electric Traveling Crane, Newburg Reduction Works, Cleveland, O.
The Brown Hoisting & Conveying Machine Co., Manufacturers.

and four hydraulic presses have been added. The conveyors run from beneath the discharge holes of each row of digesters to the presses. Mr. E. S. Peck, Superintendent of the Newburgh Reduction Co., informs us that the capacity of the dryers is now double what it was before the presses were added. Mr. Peck also says that the garbage as it comes from the digesters is comparatively dry, thus avoiding the slush and slop incident to some of the other systems.

There are four hydraulic presses, made by the Boomer & Boschert Press Co., of Syracuse, N. Y.

The [illegible] just named has, at our request, supplied us with a description of these presses, as follows:

The Newburgh Reduction Co. use hydraulic presses, [illegible] bottom up, and provided with a system of platform wheels and transfer cars for conveniently handling the material. In order to obtain a constant and steady pressure on the material an accumulator is used consisting of an upright hydraulic cylinder, provided with a piston supporting a steel beam frame, which is loaded with brick, stone or other material in such quantity as to give the water pressure desired for running the presses. Two steam hydraulic pumps force the water into the accumulator, raising the weights, which gives the pressure desired, and all three presses are operated from this accumulator, the water pressure carried being about 3,500 lbs. per sq. in. A separate pump is used to produce the low pressure, and which produces a pressure on the material of 60 or 75 tons, reducing the bulk before the high pressure is applied.

Mr. Peck informs us that these presses are "guaranteed to stand a working pressure of 300 tons, which is equivalent, on a 54-in. cheese, to 200 lbs. per sq. in."

The dryers are of the new Anderson type. The old Anderson dryers were described in the article on the original Boston reduction plant, published in our issue of May 28, 1895. A good general idea of the new dryers is conveyed by the accompanying views, Figs. 2 and 3, and their design and operation is made still clearer by the following descriptive matter, sent in response to our request by The V. D. Anderson Co.:

In this style of machine the heat is generated by coils, which are located in the square chamber, which is built to one side of the drying chamber. The heat is introduced into the dryer by means of a blast of air, which is blown over the coils and then passes down through a slot into the drying chamber. The drying chamber is provided with a shaft, which is supplied with agitators similar to those used in the old style machine.

The material to be dried is fed through the drying chamber, and, of course, comes in contact with hot air that has passed into the dryer from the coils. This dryer is especially advantageous for handling garbage, inasmuch as the shaft is accessible at all times by means of the doors, which are shown in the front view, which is of great advantage in removing any foreign substance that may get into the dryer, or making repairs when required.

Another feature that is of great value in handling materials of this kind is that there is no steam pressure around the drying chamber, and as this drying chamber is provided with a false bottom, it can be readily repaired at a small expense when the false bottom has become worn, which it is bound to do with such materials as garbage. This machine has an automatic feed and discharging device.

We have never had an opportunity to indicate the horsepower or determine accurately the amount of steam required by this new dryer. The nominal capacity of one of these dryers is 1,200 lbs. of dry garbage per hour; in other words, this is the amount of dry material that the machine turns out every hour.

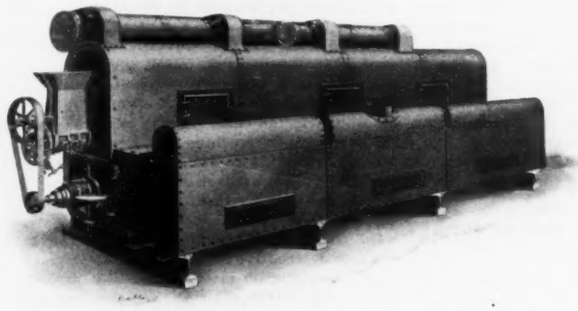


Fig. 2.—Rear View from Feed End.

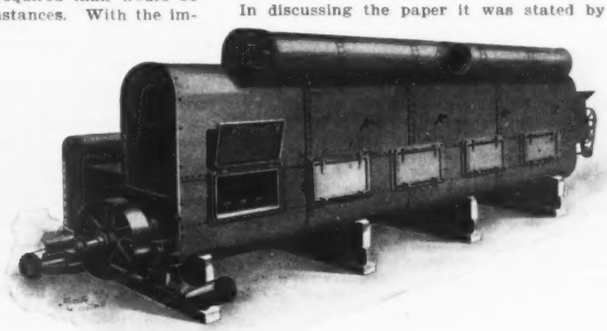


Fig. 2.—Front View from Discharge End.

FIGS. 2 AND 3.—GARBAGE DRYER USED AT THE NEWBURG REDUCTION WORKS.
The V. D. Anderson Co., Manufacturers.

The dry tankage is screened. The tailings, consisting of cans, broken glass, earthenware, pieces of iron, brick, coal and wood, which passed the sorters on the dumping floor, are thrown away. At the start, some of the tankage was made into fertilizers at the reduction works, but Mr. Peck states that on finding "that the tankage could not be used as a base for a fertilizer, but merely as a filler," the attempt to make a finished product was abandoned.

The grease is settled in wooden tanks. In October, 1898, these were located in the open, but they are now in a building erected to cover them.

Power for the works and steam for cooking and drying is furnished by four 5 × 16-ft., 75-HP. boilers. There is a 70-HP. engine; a pump; and a dynamo for electric light and power.

As to the amount of garbage treated since the plant was started, and the force required to operate the works, Mr. Peck states that from Aug. 28, 1898, when the collections were begun by the company, to the close of the year, 11,016,000 lbs. were gathered; that in 1899, the total collections were 44,757,000 lbs., an average of 72 tons per working day; and that "there were employed on an average, 25 men on the day turn and 15 on the night turn," or 40 per day. At the contract price ($69,400 a year), the collection, transportation outside the city limits and final disposal of the garbage cost the city about $3.15 per short ton.

The plant was visited by a member of the editorial staff of this journal on Oct. 3, 1898, through the courtesy of Dr. J. L. Hess, Secretary of the Board of Health of Cleveland. In the absence of Mr. Peck, the Superintendent of the works, the writer was shown about by Mr. G. E. Shotto, Foreman, but additional information has since been supplied by Mr. Peck, enabling us to describe the plant as it stood on April 9, 1900.

In general, the writer found the plant in fairly good condition. The design and location of the grease separating tanks, which were wooden boxes, above ground, resulted in some mussiness about them, but no offensive odors were noted. Statements made by Dr. Hess at the time of this visit, and reports in the local papers during the first year the works were in operation, indicated that for some time the collections were not satisfactorily made. There were also indications, in the early history of the reduction plant, that it was not always operated in the best sanitary manner, but the location being a somewhat isolated one, less care was required than would be needed under other circumstances. With the improvements made since the plant was visited by our representative, we see no reason why it should not be conducted in a highly satisfactory manner, and we have received assurances that such is now the case.

Mr. N. P. McKean is president of the Newburgh Reduction Co.; Mr. U. G. Walker is secretary; and Mr. Peck, as already stated, is its superintendent.

THE NODON-BRETONNEAU PROCESS OF SEASONING AND PRESERVING TIMBER.

A description of a new process of seasoning and preserving timber was given in a paper recently read before the Institute of Mining Engineers of Great Britain by Mr. E. G. Vecqueray. This paper has been printed with an abstract of the discussion which followed its reading in the "Contract Journal" for March 14, and from it we abstract the following passages describing the new process:

In the Nodon-Bretonneau electric seasoning and preserving process, the timber is placed in rectangular wooden tanks of various lengths (suitable to the planks or baulks to be treated), and about 3 ft. wide by 3 ft. deep. A serpentine copper steam-pipe is fixed in the bottom of the tank, and the solution is kept at a temperature of about 100° F. by the circulation of steam. Above the steam-pipe, there is an open-grid false bottom entirely covered by sheet lead, which is connected with the positive pole of the dynamo. The timber to be treated is placed on the sheet lead, and above the timber are placed porous trays consisting of rectangular wooden frames, the bottoms of which are made up of felt and canvas, supporting another sheet of lead, which is connected with the negative pole of the dynamo. The solution of "boro-resinate de soude" is then pumped into the tank until the timber is immersed to within 2 ins. of its upper surface, and pure water is placed in the porous trays to ensure good connection between the timber and the negative pole, and to assist the process of osmosis. When the current of 110 volts is started, unless the timber is very green and moist, only a small current is observed to pass through, but it gradually increases, and when it reaches a given number of amperes per cubic foot of timber, part of the solution is pumped out. The resistance being thus increased the current falls, but increases again as before; and the process is repeated until the timber is entirely out of the solution, and yet the current indicates the given number of amperes required. As may be expected, the duration of this operation varies according to the density, thickness and greenness of the timber. After the timber has been removed from the tank it is dried in the open air and warm chambers, the process, in all, taking from one to two months, according to the nature of the wood, instead of years, and at the end of this very short time the timber so treated is in better condition than naturally-seasoned wood.

Scientists are not in agreement as to the theoretical explanation of the ascertained facts of the process. The technical advisers in Paris state that the process is that of "electrical osmosis," or, as Prof. Lippmann prefers to call it, "electro-capillary attraction." The action which takes place in the well-known physical laboratory experiment with the divided cell and wet cotton, is parallel on a small scale with that which occurs in the treating tank. In detail it is as follows: A glass cell is divided by a water-tight diaphragm, each compartment is partially filled with water, and a wetted cotton or woolen thread passes from one division to the other, both ends being immersed. When a current is passed through the thread, one pole being in each compartment, the water travels in the direction of the current through the thread, and a difference in level of the water is soon produced. Comparing the two processes, the timber takes the place of the diaphragm and its constituent fibers take the place of the thread, and therefore the greener the timber, the quicker the process.

The paper cited a number of tests which had been made with the treated wood, and which showed that it would neither decay nor warp under very trying conditions where untreated timber failed to stand at all.

In discussing the paper it was stated by one gentleman that the cost of seasoning timber by the process described was about 3 pence (6 cts.) per cubic foot. Another gentleman, Mr. M. Walton Brown, stated that the solution employed consisted of 10% of borax, 5% of resin, 0.75% of carbonate of soda, and 84.25% of water. He also stated that the electric current had a tension of 110 volts, and varied from zero to five amperes, and that the treatment of the timber was completed in from five to eight hours, except the drying of it in the open air in summer, or by stoving it at a temperature of from 60° to 70° in winter. At the end of 10 or 15 days the timber could be used for any purpose.

A "BENZINE"-FIRED LOCOMOTIVE is described by U. S. Consul R. Guenther, of Frankfort, Germany. It is at work in the Laurahutte Colliery and was built at the Deutz Gasometer Works, near Cologne. As described the locomotive weighs 4,600 lbs.; is 9 ft. 2 ins. long; 2 ft. 11 ins. wide, and is 1 ft. 4 ins. high above the rail level. It runs on a gage of 1 ft. 8 ins. and develops 6 HP.; the work performed at one trip is the hauling of 13 to 14 buckets of coal, weighing about 1,375 lbs., or "about 120 metric tons per shift." To do this work the consumption of "benzine" is about 22 lbs.; and the daily expenses aggregate $1.80, including interest on investment and sinking fund, wages of engine-driver, fuel and lubricants. The cost of hauling one metric ton, or 2,200 lbs., is thus 1½ cts., as compared with 2.5-6 cts. for horse-hauling. This engine is closed in on all sides, so that the driver can only get at the interior by using a key, and the danger of explosion is practically obviated. With the exception of one slight accident, easily repaired, this locomotive has worked satisfactorily for over one year.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post-Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY

GEO. H. FROST, - - - - - - - - - - PRESIDENT.
D. McN. STAUFFER, - - - - - - - - VICE-PRESIDENT.
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F. P. BURT, - - - - TREASURER AND BUSINESS MANAGER.

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ALFRED E. KORNFELD, New York,
M. C. ROBBINS, Chicago,
S. B. READ, Boston,
C. F. WALKER, Cleveland, — ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 170 SUMMER ST.
CLEVELAND OFFICE, OSBORN BUILDING.
LONDON OFFICE, EFFINGHAM HOUSE, 1 ARUNDEL ST., STRAND.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00. To all other countries in the Postal Union: Regular Edition, One Year, $7.00 (31 shillings); Thin Paper Edition, One Year, $6.31 (26 shillings). SINGLE COPIES of any number in current year, 15 cents.

In requesting change of mailing address, state BOTH old and new address; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 320 means that subscription is paid to the 32d week (that is the issue of Aug. 9) of the year 1900; the change of these figures is the only receipt, unless one is sent by special request.

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The establishment of a National Standardizing Bureau to replace the present Office of Standard Weights and Measures is advocated by Secretary of the Treasury Lyman J. Gage in the draft of a bill submitted to the House Committee on Appropriations as an amendment to the Sundry Civil bill. This bill is certainly very modest in the light of the benefits to be conferred upon the scientific and manufacturing interests of the country. It proposes that this new bureau shall have custody of all standards; shall compare standards used in scientific investigation, and in engineering, manufacturing, commerce and educational institutions with the standards recognized or adopted by the government. It is to construct, when necessary, standards, their multiples and subdivisions; to test and calibrate standard measuring apparatus; and to solve all problems arising in connection with standards. The bureau is also to determine physical constants and the properties of materials where such data are of great importance to scientific and manufacturing interests and are not attainable elsewhere with sufficient accuracy. The bureau is to exercise its functions for the government of the United States and, under proper rules and regulations for any state or municipal government, or for any scientific or educational body, firm, corporation or individual within this country requiring the use of standards. The bill names as officers a director of the bureau, at $6,000 per year; a physicist, at $3,500; a chemist, at $3,500, and two assistant physicists or chemists, at $2,500 per annum, together with laboratory assistants, secretary, clerk, etc. The act would appropriate $34,900 for salaries, $250,000 for the erection of a suitable fireproof laboratory, $25,000 for its equipment, $25,000 for the purchase of a site, and $10,000 for the general expenses of the bureau.

There can be no question as to the usefulness of such a bureau and of the value of appliances and methods of standarizing not now available in the existing Office of Standard Weights and Measures.

We have already fallen behind foreign governments in this matter. In electrical and magnetic measures, for example, we must go to England or Germany for our standards. In accuracy of workmanship and in the use of precise standards of measurements American manufacturers are unexcelled; but there is still a need for the authoritative establishment of standards, and a work so manifestly for the public benefit ought not to be left to private enterprise alone. The work of such a bureau would benefit, moreover, every scientific department of the government, which now have too frequently to procure from abroad the standards and instruments of precision employed simply because of our lack of facilities for standardizing.

While the bill only incidentally mentions the determination of physical constants and the investigation of the properties of materials, work in this direction might furnish a large field of usefulness for a government institution. Much of this research is too costly to permit thorough investigation by individual effort alone. As an example of what can be done in this field we have the work commenced by the Bureau of Forrestry in the study of the properties of American timber. Results of great value have already been secured, and we can only regret the unappreciative action that shut off appropriations and throttled the further prosecution of this important economic study. One of the most hopeful features in the new departure proposed by the Secretary of the Treasury is that with a bureau of this character actually established for a specific purpose Congress would be more apt to recognize its public usefulness and provide ample means for its continuance. The United States can equip and operate a standardizing bureau that would have no superior anywhere; and the investigators, and especially the manufacturers of this country, should unite in a demand for its inauguration.

THE PREVENTION OF LOSS FROM FIRE BY MUTUAL INSURANCE.

An interesting review of the development of mutual factory fire insurance in the United States is given in a report recently published by Mr. Edward Atkinson, President of the Boston Manufacturers' Mutual Fire Insurance Co. As most of our readers are doubtless aware, the principle upon which mutual insurance is conducted is that the only persons who can prevent loss by fire are the owners or occupants of the insured premises. It is argued that upon these persons rests the responsibility for heavy loss, if any occurs, in nearly every fire; all that the insurance company can do is to pay indemnity for loss, which, if large, in nine cases out of ten, is due to the lack of apparatus for preventing loss or to lack of care and order in the conduct of the work. Based on this assumption, the practice of mutual insurance companies is to instruct owners and occupants regarding fire prevention devices and methods and to keep them up to the mark in providing against fire by refusing to grant indemnity to those who are negligent. The soundness of this reasoning is apparently borne out by the success with which mutual factory fire insurance has met as it is outlined by Mr. Atkinson's report.

According to this report, mutual insurance for factories was established in 1835 by the late Mr. Zachariah Allen, of Providence, R. I., by the organization of the Providence Manufacturers' Mutual Fire Insurance Co. The Boston company, of which Mr. Atkinson is President, was founded in 1850, and was the third company of its kind to be organized. The report states, however, that it was not until 1880 that the science of preventing loss by fire was fairly entered upon, in line with the principle noted above. In that year automatic sprinklers were first introduced; the risks were carefully classified and studied; special fire-apparatus under drilled men was insisted upon, and a beginning was made in the careful study and development of factory construction, which now forms so prominent a part of the regulations of these insurance companies. In 1882 the system of roof-hydrants, supplied by a powerful steam pump, was held to be of prime importance in the protection of large cities from conflagration; and a short treatise on this subject was then published by Mr. Atkinson and the late Mr. William B. Whiting. These roof-hydrants have often proved their usefulness; and especially did so in the great fire in Philadelphia last January (Eng. News, Feb 1, 1900).

Among the reforms brought about in the construction of factories by the requirements of the mutual insurance companies may be noted the suppression of the so-called barn-roof, which by its construction permitted a long hollow space behind the ceiling at the eaves. In this space rats made nests of oily waste, and the spontaneous combustion of this waste caused a number of fires. A large fire loss was found to be due to broken lanterns, and the efforts of the company to find a safe light of this character that was not too expensive produced the lanterns of the F. C. Dewey Co. Since the compulsory introduction of safe and suitable lanterns the report states that "there has not been a loss of any considerable amount in the works insured by the Boston Manufacturers' Company."

A rather prolific cause of fires was found in the various oils used for lubrication and for smearing wool. For lubrication, though mineral oils were largely employed, mixed oils and fine sperm oil were deemed most suitable; and for smearing wool, olive oil, lard oil and various mixtures more or less liable to spontaneous combustion were used. The spontaneous combustion of waste has been almost wholly removed from cotton factories by substituting mineral, or the so-called paraffine oils for lubrication, in place of animal oils having an affinity for oxygen. Investigation also showed that 33% of mineral oil mixed with lard oil would overcome any tendency to spontaneous combustion; and 25% of the mineral oil mixed with sperm oil would do the same. These mixtures, however, do not serve in machine tool-work; and there is still some liability to fire in the repair shops where pure lard-oil is used on the cutting tools. In the woolen mills the danger has been much reduced by the discovery of methods whereby scouring wool is treated with mixed oils, partly mineral oils.

Many destructive fires originated from hot bearings, especially on main shafts. An inspection of nearly 100 cotton mills showed that the average price paid for lubricating oil varied from 29 cts. to $1.05 per gallon; and the general opinion was that the users knew little of the oil employed, and it was time to bring lubrication to a science. As a result of careful and intelligent study mineral lubricating oils are now made of various qualities, more or less fluid and more or less filtered; with the price ranging from 13 to 30 cts. per gallon for such oils as are used in ordinary cotton machinery. All makers of dangerous oils were warned that the members of the company would be prohibited from using their oils; and though a suit at law was threatened for interfering with their business, the methods of distillation were changed and the cost greatly reduced. Accidents from hot bearings are now very rare.

Mr. Atkinson says that sawdust is a dangerous incendiary. The least bit of grease, oily rags and the like, will bring on rapid oxidation, commonly called spontaneous combustion. He is convinced that, in some instances, large masses of material subject to slow combustion, have been ignited in this way, producing large volumes of combustible gas and filling the interspaces of buildings of hollow construction. When a spark ignites the gas at a point where it may obtain a free supply of oxygen, an explosion occurs and the whole building is quickly destroyed. Mr. Atkinson notes a case where a wooden shed on his own premises was fired by a greasy ham bag which had been thrown into a barrel and then covered with a lot of excelsior and other rubbish. As he carried a policy of insurance on his library in the company of which he was President, he added to the report of this fire that "this member has been warned by the President that if he permitted combustible material to be put away in wooden barrels, his policy would be immediately cancelled."

The building of fire-doors has been thoroughly investigated by the company, as the warping of iron fire-doors had caused one of the heaviest losses in the company's experience. Tin-clad

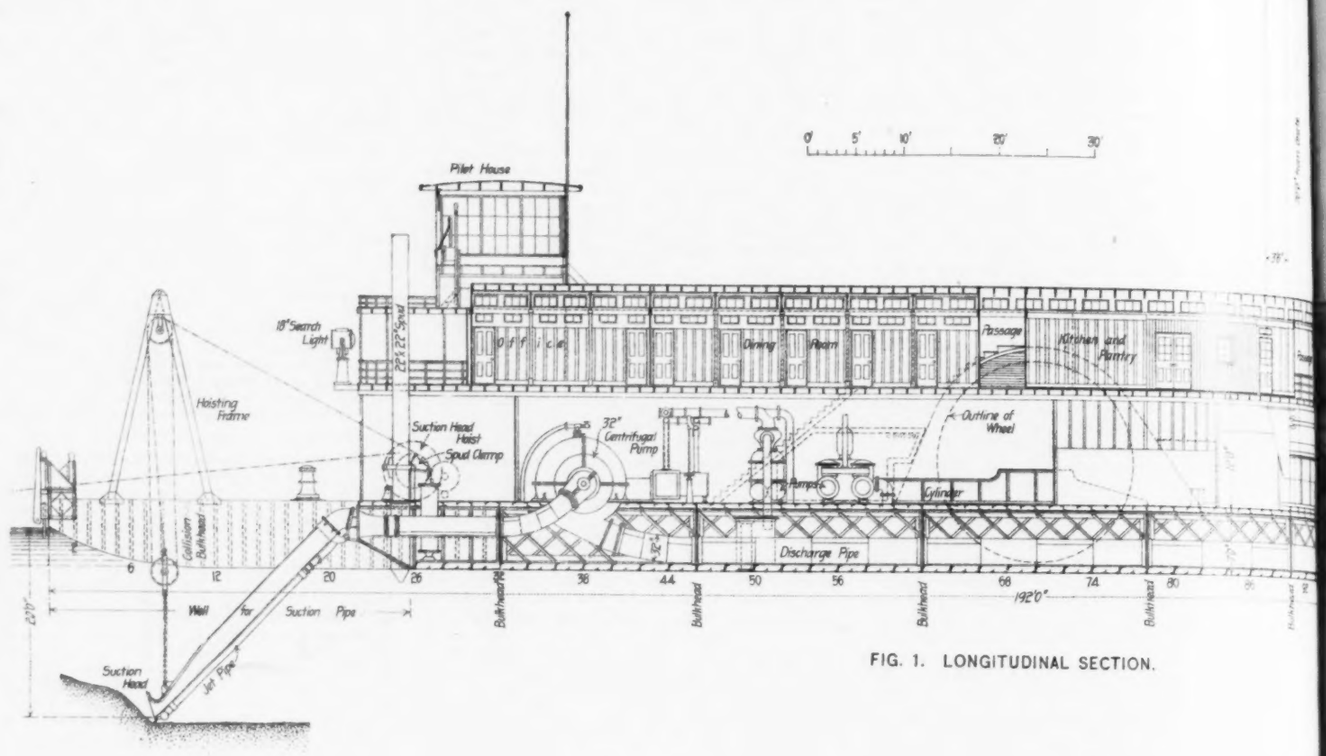

FIG. 1. LONGITUDINAL SECTION.

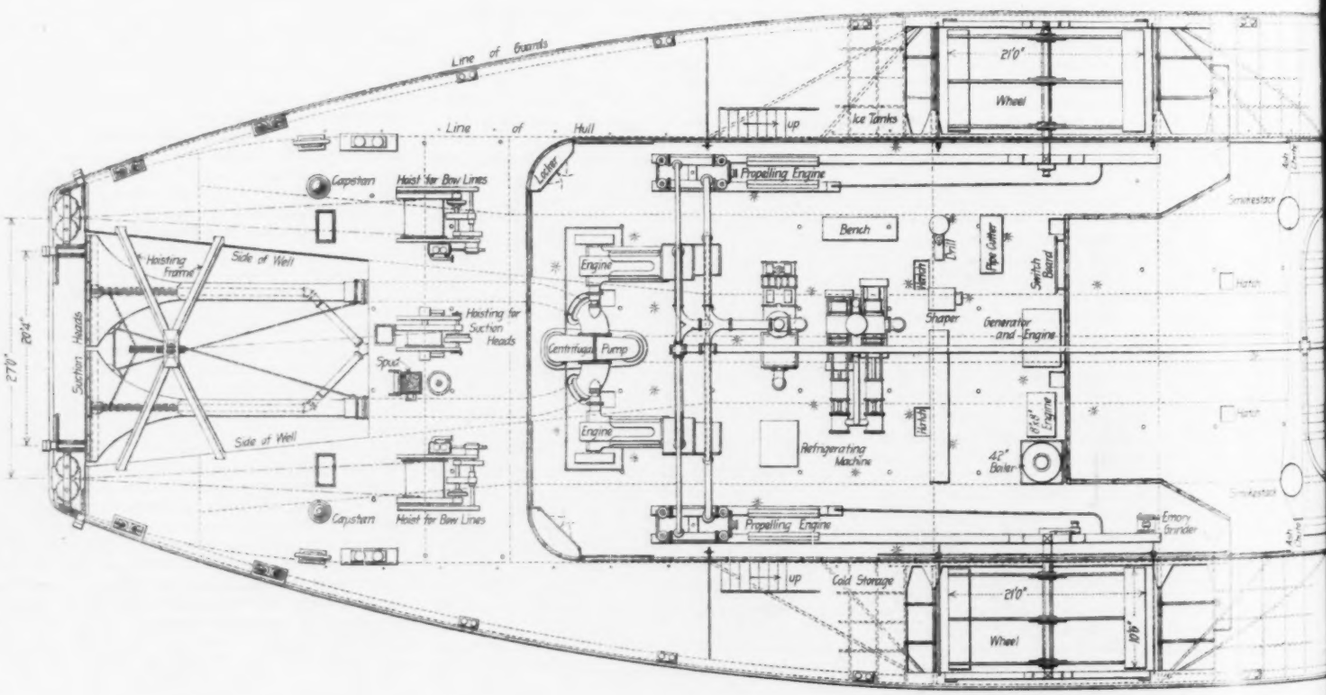

FIG. 2. MAIN DECK PLAN.

SELF PROPELLING HYDRAULIC DGE FO

Capt. Mason M. Patrick, U. S. Engineer, S ty of the

Thomas Middleton, Assistant Engineer.

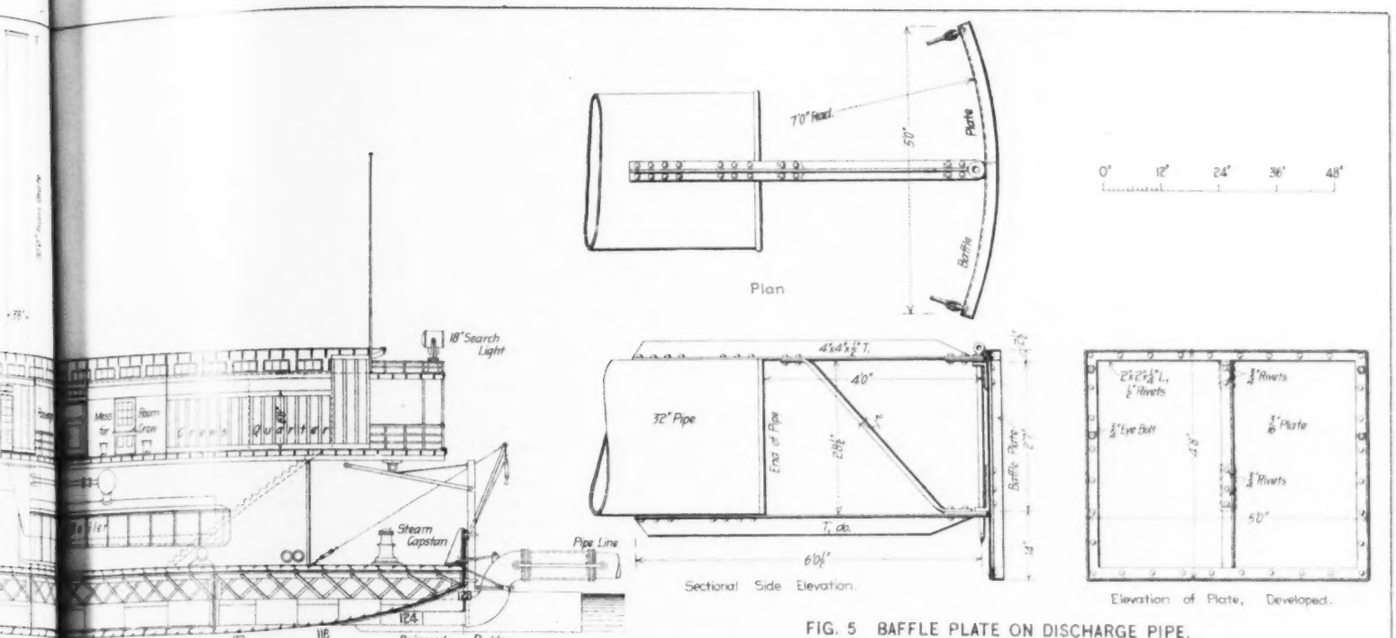

FIG. 5 BAFFLE PLATE ON DISCHARGE PIPE.

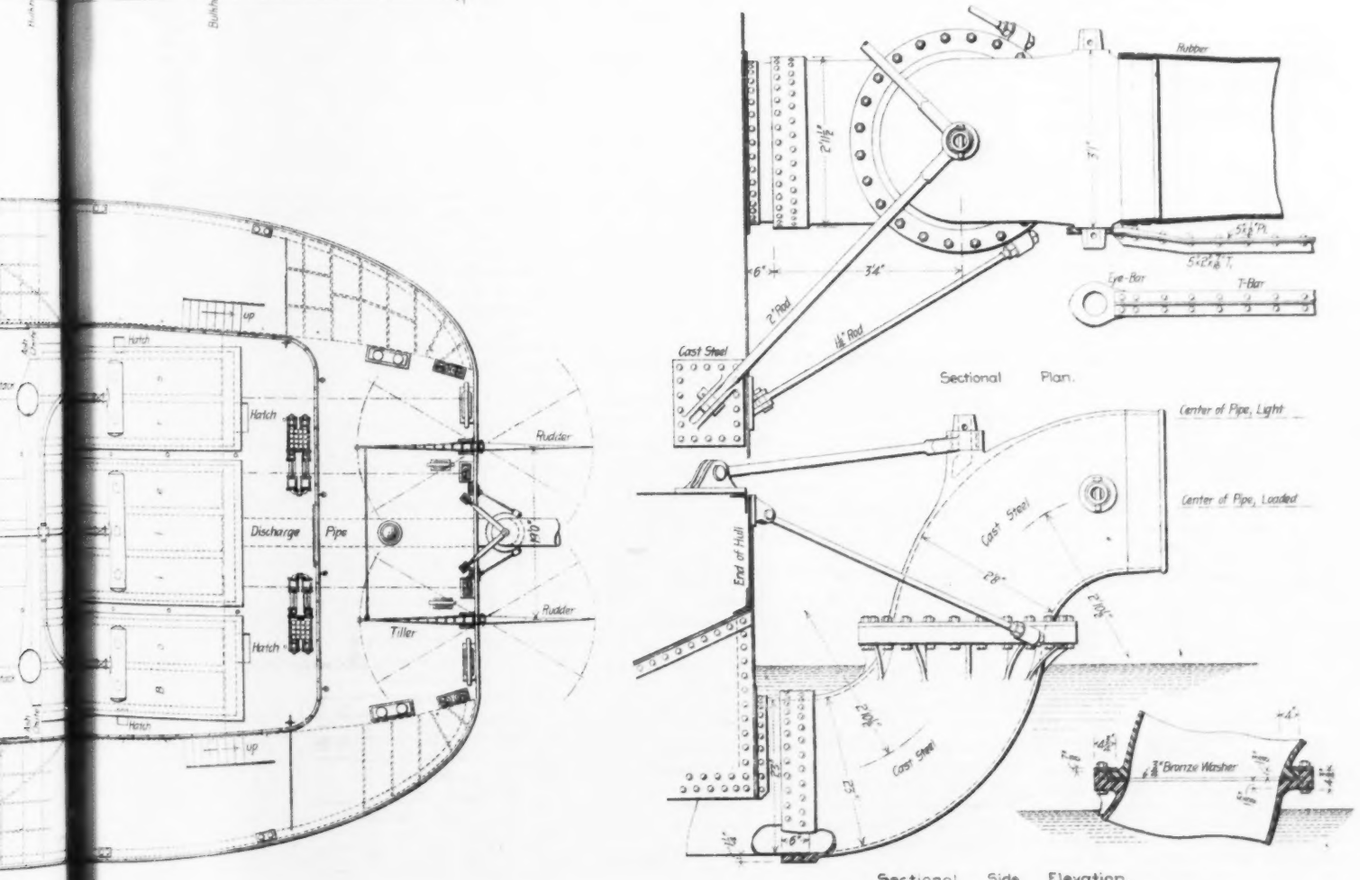

FIG. 3. SWIVEL ELBOW OF DISCHARGE PIPE.

DRAULIC DGE FOR MISSISSIPPI RIVER.

ngineer, S ry of the Mississippi River Commission.

Springfield Boiler & Mfg. Co., Builders.

CHAS. HART, LITH., 99 VESEY ST., N. Y.

...ors, and sliding doors were introduced, ...ctions issued for their construction. The ...using cheap fire-hose "to satisfy the in...spectors," brought about information ...ll members as to whom they could trust ...rchase of hose; and the subsequent es... ...nt of types of hose designated as the ...iters" hose and readily identified. The ... automatic sprinklers is only briefly ...upon, as it is well known. Mr. Atkinson ...wever, that his efforts to introduce them ...always received in the proper spirit; and ...ber who was irritated by his persistent ...for sprinkler protection suggested to Mr. Atkinson that when he passed on to some other life, he had better take with him a sprinkler for his own protection.

Before 1890, the common practice was to heat buildings by steam pipes fastened to the walls at the side of the room, near the floor, and where they were apt to be in contact with combustible material. After several fires had originated from these pipes, the members were induced to hang them overhead; and this proved to be the right way to warm the floors, to save fuel and to avoid many dangers. In one case in a high basement with a stone floor, in which no one could previously work without wearing wooden shoes, the placing of the pipes overhead warmed the floor and made the room useful.

The covering of steam pipes to prevent radiation was investigated by Prof. John M. Ordway; and in investigating asbestos as a non-heat conductor the merits of magnesia as a heat retardent were disclosed. Many new compounds have been more recently tested by the Mutual Boiler Insurance Co., of Boston, and by Mr. Charles L. Norton, at the Institute of Technology. The demerits of compact asbestos have been disclosed, and the merits of air-cell asbestos, granulated cork and magnesia covering have been accurately compared.

The wooden posts of factories, instead of being turned and tapered from base to top, are now made square with chamfered corners; and a hole is bored through the center with cross holes near the top and bottom, to ventilate and season the timber. Tests show the square posts to be superior to the older form. As one result of the tests of the strength of timber, general plans for cotton mills, machine shops, paper mills, etc., are kept in stock for the use of members. In the same direction, Mr. John R. Freeman, M. Am. Soc. C. E., has specially treated the pump, pipe and hydrant plant suitable for factory use. The rules for sizes of iron pipes, sizes of hose and play-pipe, sprinklers and their proportions, have all been thoroughly established, tabulated and issued along with the names of reputable makers. In the same way the dangers of electric lighting, introduced in 1877, have been carefully studied and rules are laid down for setting up electric lighting plants.

In discussing the fire loss in the United States, Mr. Atkinson claims that this loss annually represents at least 10%, and probably 15%, on the annual profit of the entire nation, now placed at about $1,500,000,000. This tax is equal to the cost of conducting the government of the United States, under normal conditions, excluding pensions and interest on the national debt. For this great loss to the country the owners and occupants of dangerous buildings are responsible, and they must pay the penalty. Until these men act in combination under intelligent advisers, big fires will be their own fault. In referring to the "Dry Goods District" of New York, Mr. Atkinson says that in an area of less than 120 acres property in buildings and contents has been concentrated, the value of which is computed at from $350,000,000 to $500,000,000, or 1½% of the entire capital of the United States. Upon this property not less than $1,500,000 is annually paid in premiums on fire insurance; and these premiums have been subjected to an average annual loss of $1,000,000 for the last ten years. The loss in 1879 was nearly $4,000,000.

In speaking of the better protection of this district, and after showing that a recent report of the underwriters discloses the fact that for a large part of each day there is no pressure upon the street hydrants at the street level in this district, the writer advocates 6-in. stand-pipes. He proposes to erect such stand-pipes at two corners of a given acre of buildings, to which could be attached 5-in. horizontal pipes upon the roofs fitted with hydrants on each side of each party wall. These pipes should be carried around each square of buildings, and the power applied by fire-engines stationed at the corner most distant from the fire. The Abner Greenleaf water tower partially meets this demand; but Mr. Atkinson believes that the other system would be more effective, and he computes the cost of the roof-hydrant service at less than $2,000 per acre thus protected. If large pumps be permanently established to feed this service, taking water from the city mains or the river, these pumps and their accessories would raise the cost to about $7,500 per acre.

LETTERS TO THE EDITOR.

Some Notes of an Experience With Teredo Navalis.

Sir: An interesting fact in the use of piles in Teredo-infested waters has come under my observation. It may be generally known, but I have never seen any record of it. For several years a friend of mine has maintained a fishing pound at the shore of the Atlantic Ocean near Fire Island inlet. The poles for this have been mostly of hickory, with a few of oak. These have been put down with the water jet, and apparently could have been used for more than one summer but for the worms. Just inside the inlet, out of the reach of the ocean storms, a "pen" has also been maintained, in which to keep the fish for convenient marketing seasons. The poles for this, because of low first cost, were of the native pitch pine, known locally as "Long Island pine," which were put down when freshly cut. No sign of a Teredo has appeared in these pine poles, although they have been carefully examined, even to the extent of some of them being cut to pieces. The conditions here and at the site of the pound are practically the same, except as to storms; and no other wood, even the pine itself, when seasoned, would last in either place for more than a season on account of the worms. A car for transporting the fish from the pound to the pen, which was kept moored to the pen when not so in use, fell to pieces in one week. Its frame, which was completely annihilated by the Teredo, was of 8 × 8-in. spruce. The longest period of observation of these pine poles has been three successive years for any single specimen. It is needless to say that every consideration of economy has dictated the use of freshly cut pine wherever its limitations of length and elasticity would permit.

Eugene R. Smith.

Islip, N. Y., May 24, 1900.

Diagrams for Determining the Weights of Bridge Spans.

Sir: Referring to the diagrams for determining the weight of bridge spans (Eng. News, May 10, 1900), I write for some light. The weight per foot is stated, $W = \frac{\text{Span} \times \text{total load per foot}}{F \text{ (taken from curves)}}$. I have in mind the following actual weights of plate girders:

65.4 ft. span, 45,474 lbs. per foot = 695 lbs.
45.25 " " 24,844 " " = 549 "
28.5 " " 12,120 " " = 426 "

Take diagram:

65.4 ft. span × 4,000 lbs. total load per ft. ÷ 1,220 = 214
45.25 " " × 4,000 " " " " " ÷ 1,220 = 148
28.5 " " × 4,000 " " " " " ÷ 1,220 = 93

Again take diagram Fig. 1, plate girder, 100-ft. span:

100 ft. × 4,000 lbs. ÷ 1,220 = 328.

Diagram Fig. 2, trusses:

100 ft. × 4,000 lbs. ÷ 610 = 656.

What is the matter? Perhaps I do not understand the workings of the diagrams.

Bridge.

(The confusion of our correspondent is doubtless due partly to the error in the printing by which the titles of the diagrams to which he refers became transposed and partly to the assumption that the diagrams give weights of bridge spans istead of weights of trusses and plate girders. —Ed.)

Some Facts Respecting the Early History of the Rotary Cement Kiln in America.

Sir: Without any intention of criticising the very interesting article which appeared in Engineering News of May 3, entitled "The Influence of the Rotary Kiln on the Development of Portland Cement Manufacture in America," I offer you the following additional information to use as you think best:

Having devoted many of the best years of my life and a sum of money which would now be a fortune for me if I had it in developing the Portland cement industry in this country, I feel that my services deserve some historical recognition, since they have had no other. I think it was in 1883, at the time the "Morrell Tariff Commission" of Congress was taking testimony upon which to base duties, certain importers of cement had appeared before the commission petitioning that Portland cement be put upon the free list, as it was not and could not be an article of manufacture in the United States, there being no materials in the country out of which it could be produced, that I was called upon by Mr. Randel, of the commission, who knew of my work, to refute this statement. I did so by presenting certificates of tests and reports of the cement then being produced by the Wallkill company, on the Hudson River, and by Saylor's company, at Coplay, Pa.

Mr. Saylor was the pioneer in developing the manufacture from the alluvial limestone, or shale, of the Lehigh region. I was familiar with his early experiments, many failures and final success. I argued with him that the variation in proportion of lime, silica and alumina of the different strata of shale would make it practically impossible to produce a uniform cement. It was thought at the time that the rock suitable for Portland cement was confined to a limited area and deep strata. It has since been found to cover a very large area in that section of Pennsylvania and the adjoining State of New Jersey.

If it was necessary to mix raw materials, it seemed to me preferable to adopt the European method of mixing a comparatively pure carbonate of lime with a suitable clay (silicate of alumina) and thus arrive at continuous uniform results. I therefore took up the development of the industry on these lines, instead of joining Mr. Saylor, as invited to do.

With the assistance of Mr. J. J. Crane, of Hackensack, N. J., an experimental plant was first erected at Croton Landing, on the Hudson, followed by a commercial plant of about 25 bbls. per day capacity, erected at Carthage Landing, on the Hudson. At this later plant we had two up-light kilns of the common European construction. Here excellent results were obtained from a mixture of Rondout limestone and clay. Tests and reports of the cement produced at these works, made by E. C. Clark, of the Boston Sewerage Department, and W. W. Maclay, of New York, Department of Docks, and its use in various important constructions, demonstrated our ability to manufacture a superior cement with the materials and process adopted. We were also satisfied it could be made a commercial success on a larger scale.

The Wallkill Portland Cement Co. was organized, and works with a capacity of from 200 to 300 bbls. per day were erected in 1882 at South Rondout, N. Y. At these works the limestone and clay were ground dry, mixed in proper proportion, steamed and formed into bricks, which were stacked on iron cars and passed through drying channels heated by the products of combustion from the kilns, of which there were 16, domed over and connected by flues with the drying channels and a tall chimney. Gas house coke was used at the experimental and Carthage Landing works, and at first at the Rondout works, but at that time changes were being made in the process of making gas, the water gas process taking the place of the coal distillation process, resulting first in restricting and finally the extinction of our available gas coke supply. We were then dependent upon the Western coke, the transportation of which by rail and transfer to our works increased the cost of manufacture very largely. I then commenced a series of experiments with crude Lima oil—which was on the market at a low price—erecting several modified forms of upright kilns for this purpose. It was found impracticable to burn the raw materials of Portland cement in an upright kiln. The necessary heat for clinkering fusing the material in front of the burners, prevented the flame penetrating the mass of the kiln. Knowing that this same difficulty had been met with in metallurgy and had been overcome by use of rotary kilns, or furnaces, it was natural to look in this direction for a solution of the problem. I found that on Dec. 9, 1851, Mr. A. S. Beadleston was granted U. S. patent No. 8573 for "improved revolving reverberatory furnace," which covered the use of "rolling or revolving" furnaces "for any purpose" for which ordinary furnaces or "kilns" were employed, following which were innumerable improvements in revolving furnaces, bar roasters, etc., including the well known Siemens furnace of Aug. 17, 1869, Patent No. 93,758. I also learned that in 1880 or thereabouts Dr. George Duryee, of New Jersey, had erected a rotary furnace or kiln at Toledo, O., in which, with an oil flame, he had calcined lime and clinkered the raw materials for Portland cement, patents being granted him in January, 1881, for his improvements in construction, etc. Securing from Dr. Duryee the plans and details of this construction, we erected a rotary kiln at the Rondout works, which, after considerable experimenting, was made very successful, the one rotary kiln burning all the material the mill could supply and doing away with the necessity of wetting, forming into bricks and drying, the raw materials being ground, mixed and fed continuously into the kiln. In 1889, after having passed through all this experimental stage and starting out for practical results, our works were entirely destroyed by fire, resulting in great financial loss and my retirement from the field.

Nov. 17, 1885, and April 20, 1886, Mr. Frederick Ransome, of England, was granted U. S. patents (patented in England May 2, 1885) for "manufacturing cement, etc.," in which rotary kilns are described and used in combination with gas producers, oil or powdered coal not being contemplated. In 1886 Henry Mathey was granted various patents for "coloring," combining materials, etc., none of which are in use or are of any value. Based upon these patents of Ransome and Mathey, a highly capitalized company was organized, which, after various reorganizations and expert financiering, has developed into probably the most extensive cement manufacturing concern in the world.

All attempts of this company to produce a reliable cement had been failures, until, after the destruction of the Wallkill works, they secured the services of a chemist who had been in my employ during our rotary kiln experiments and was well informed as to the necessary chemical

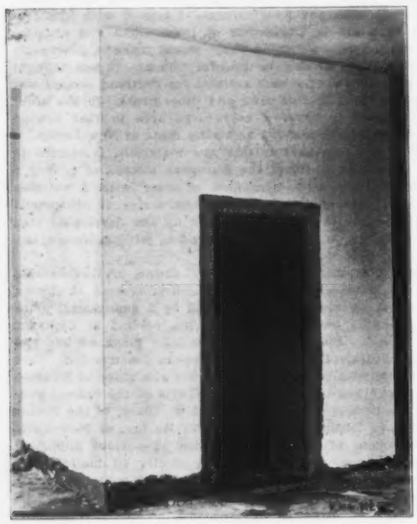

Fig. 2.—General View of Vault Before Placing Door and Base-Board.

properties of the raw materials, degree of burning, etc. Soon after this another of our employes, who had learned all he knew about the business through his connection with the Wallkill company, was employed to supervise the erection of two other Portland cement works located in New Jersey, in which rotary kilns are used and which are very successful enterprises.

I did not intend going so much into details when starting out, but have found it necessary, in undertaking to state the facts in connection with the development of the rotary kiln and some neglected portions of the history of the development of the manufacture of Portland cement in the United States. Yours respectfully,

J. Gardner Sanderson, C. E.,
Mem. Am. Soc. C. E.

1880 Sanderson Ave., Scranton, Pa., May 19, 1900.

A FIREPROOF VAULT BUILT OF CONCRETE AND EXPANDED METAL.

We illustrate herewith a fireproof vault recently built for the Domestic Exchange National Bank of New York by the New York Expanded Metal Co. The bank occupies a portion of the third floor of the new fireproof building known as the "Broadway-Chambers," corner of Broadway and Chambers St., and a vault was desired that should be of sufficient fire-resisting quality to withstand any fire likely to arise in such a fireproof building, that should not be too heavy to be supported by the floor of the room, that should not waste too much room in thickness of its walls, and that should be reasonable in cost. Different vault builders proposed styles of vault which did not satisfy one or more of these requirements. These included vaults built of two thicknesses of boiler plate steel separated three or four inches, and the space filled with plaster and brick, and vaults of brickwork varying all the way from a single thickness of cellular fire-brick 4 ins. thick up to solid brick walls 2 ft. thick.

A suggestion was made by Mr. William Kent that a suitable vault could be constructed of a combination of expanded metal and Portland cement concrete of the same kind as is used in fireproof flooring, viz.: the mixture of one part cement, two of sand, and four of coal ashes. This mixture in the tests made by the New York Building Dept. some two or three years ago showed remarkable resistance to fire and to heavy loads at the same time. The vault was constructed by the Expanded Metal Co., as shown in the accompanying illustration. The irregular outline at the rear is due to the presence of one of the supporting columns of the building. The door-jambs were made 1 ft. 8 ins. deep, as shown, in order to accommodate an iron door casing, with double doors inside, which open and fall back against the jamb, and one large outer door. The doorway was roofed over with a slab 3 ins. thick, made of concrete and expanded metal. The floor, as well as the roof of the vault, was also made of concrete and expanded metal, the ordinary filling on top of the tile-brick being removed down to the level of the top of the floor girders and its place supplied by the concrete.

In building the vault a structure of upright wooden posts of horizontal planks was built of the dimensions of the inside of the vault, then outside of this three inches away from the face of the planks, the sheets of expanded metal were hung, then an outer casing of planks six inches away from the inner casing was built as the filling in of the concrete proceeded. This was the plan followed by the building of the two side walls and the front. In building the rear walls the partition walls between the adjoining rooms formed one side of the mold for the concrete, and the inner planking, which was raised as the filling proceeded, formed the other. The expanded metal used was a single sheet of 3-in. mesh made of No. 10 steel. We are indebted to the New York Expanded Metal Co. for the drawing and photograph of the vault from which our illustrations are made. The photograph was taken before the insertion of the door casing, and the placing of a plaster baseboard around the bottom of the vault.

EDUCATION OF MACHINISTS, FOREMEN AND MECHANICAL ENGINEERS.*

By M. P. Higgins.†

The expert opinion and valuable suggestions presented by the members of this society in the discussion upon the subject of the "Education of Machinists, Foremen and Machanical Engineers," at the last meeting (Eng. News, Dec. 7, 1899), proved to be of such interest and value that there has been a general demand that the discussion be continued at this time.

It is quite evident that there is no general deep appreciation of the dignity and importance of the position of the mechanic. I am persuaded in my own mind, after years of thought and observation, that there are very sound reasons for assigning to the position and calling of the mechanic a certain elevation and superiority above that of any other profession. So far as the kind of work effects the character of men, nothing in the line of human activity is so well calculated to develop the imagination in the direction of the creative powers of the human mind as the designing and making of machinery. No other branch of human knowledge has made such wonderful advances as has mechanical engineering within the past century. So much I have said with the sincere belief that I have not overstated it, in order to show that we have abundant grounds for the highest appreciation for the calling of a mechanic. In the term mechanic I include all manufacturers, engineers and others engaged in the production of things useful.

The Requirements of the Machinist of To-day.

Prof. D. S. Kimball, of Sibley College, says: "I do not believe that the manual skill required of the machinist today is as high as that of 30 years ago." And this view has been taken by a writer in the "Railroad Gazette" of recent date. Our system of automatic machinery and division of labor by piece-work is suggested, very falsely, I think, to sustain this view.

In reply to such a claim, I would say we shall certainly suffer great loss if we are allowed to be led into any such error as this. Automatic machinery, systems of piece-work and division of labor do not and will not lower the requirements of the machintst's skill and knowledge. Although these changes enable the manufacturer to make a larger use of unskilled laborers as operatives, yet, on the other hand, the requirements for skill of the machinist have been raised, not lowered. He must think more accurately, make more exact measurements, work [illegible]ened steel parts to a degree of precision which was not [illegible]ght of by the old-time machinist.

We must not be misled by the observation of [illegible]matic machinery turning out the most exact work [illegible] such rapidity when operated by a rough boy called in [illegible] the streets or farm. In addition to the superior skill [illegible]uired of the machinist to construct these automatic [illegible]hines, we should remember that it is not safe to run [illegible]m a single day without the presence of a skilled [illegible]hinist, who may be called upon to make an adjustment, [illegible] detect a mysterious fault in its action, to adapt it to a new [illegible]m of product, or to refit or make a new member requi[illegible] exactness and an accuracy of measurement that would have been impossible to the ordinary machinist of thirty years ago.

I am of the opinion that if all our present [illegible]roved automatic machinery and refined shop instrume[illegible] and machine tools could have been delivered and set up in the machine shops of thirty years ago, there would not then have been skill enough to make good use of them.

Thus the use of automatic machinery, so marvellous in extent and accomplishment, may lead one to a false conclusion regarding the requirements of our future machinists. The field of the machinist has broadened so greatly that he does not find himself replaced, as the newspapr compositor is replaced by the linotpye operator, but he is called upon to construct hundreds of new machines, to make new products. If an automatic bolt cutter, for example, relieves him of a portion of his former duty, he is still needed in making the machines which are replacing hand labor in other trades. He is making automatic shoe machinery, automatic typesetting machinery, automatic sewing machines, automobiles and hundreds of machines used to fill wants not known or felt fifty years ago. He is replacing the skill in the other arts and manufactures by his own skill.

Such is the superior skill required of the machinist today, in order to keep our highly organized machines working properly, that the training of machinists becomes of the greatest moment in the question of national mechanical supremacy. While France, Switzerland and Germany are giving training in development of skill among all classes of their mechanics below the mechanical engineer, we cannot fall into greater danger than that of feeling secure and confident that automatic machinery, shop

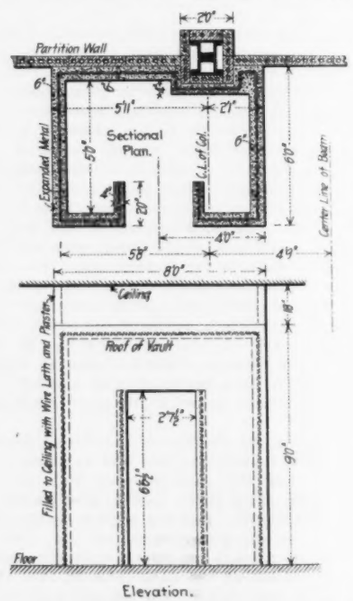

Fig. 1.—Plan and Elevation of Fireproof Vault of Concrete and Expanded Metal.

systems or what not will take the place of mechanical skill and scientific shop training of our machinists. And we must not forget also that the perfection of our machine tools and of our small tools and of our automatic machinery, which have been evolved, invented, made, improved and perfected by machinists, is due to them rather than to any other class of men in the line of mechanical industry. Furthermore, this high development is the direct result of the personal observation and experience of skilled machinists in the actual performance of work by the old and poorer methods. Through their daily experience they felt the need and met it.

Just as sure as the American mechanic sits down to smoke complacently, because he has an automatic machine which is kept going by a thoughtless operative, just so sure will he find himself behind in the race for mechanical supremacy.

*Condensed from a paper presented at the Cincinnati, O., meeting of the American Society of Mechanical Engineers.

†228 West St., Worcester, Mass.

American Boys Not Learning Trades.

The fact that so very few of our best American boys are learning trades, with a loving intention of working at them, is of the most important significance. If our larger machine shops are visited it will be seen that where apprentices are found nearly all the places are filled by boys of foreign parents. I have made inquiries in several large cities, and find that only a few shops are able to offer good opportunities for learning the machinist's trade, and that there are constantly a large number on the waiting lists; not often not over one-third or one-quarter of the acceptable apprentices are American boys; also, that the American boys are the most unsatisfactory. By following up this surprising statement I found that while the American boy has the natural mechanical ability, he lacks that reliability and vigor which comes from a less delicate home life.

I mention this phase of our American life to show one reason why more of our boys are not learning trades and becoming leaders in a very promising field. It seems that the real solid inducements for learning a trade are being overshadowed by a few imaginary objections. Do not our boys feel that a mechanic must be deprived of too much time for social enjoyment and leisure, that some of the refinements of life must be given up, that the garb of a machinist and his surroundings are not to be desired, and possibly that his associates will be inferior and undesirable? Add to these the objection of being unable to dress in "purple and fine linen" and keep the hands clean, and I think we have the principal reasons why American mechanics are growing proportionately fewer every year.

The boys with foreign parents are coming to the top, not because of their natural mechanical ability, but from their willingness to learn trades. In a few years these boys will stand ten to one American in our industries. You may say, What of it? I answer: I am not sounding an alarm against the foreign mechanic, because he is a foreigner, but because I believe that only by the superior native skill of Americans can our industrial supremacy be held. We are dependent upon this, and for this reason we cannot allow our best boys to shun the shops and the trades for lawn tennis, golf links, football fields and eventual clerkships.

Our foreign competitors are offering greater opportunities to their mechanics than they offered thirty years ago, and are endeavoring to do more for them to-day than we are. Practical trade schools are being established and a wide-spread interest is aroused among thinking men of Europe in industrial education. It is not safe for us to think that our native mechanical aptness will always offset the value of better advantages and training, especially if foreigners select their brightest young men to go into their shops and our brightest boys are not induced to learn mechanical trades.

The Difference Between the Machinist and Engineer.

Having set forth above what I mean by the term "machinist," and what the significance of his position is, it seems to me that the fundamental idea upon which the proposition of the half-time school is based must be admitted, if the difference between the machinist and the engineer is recognized as a difference of degree and not of kind. There is no defined line of demarkation between the mechanic and engineer, and the same fundamental training may be made suitable for the successive grades of mechanics up to and including the mechanical engineer. The latter would have this schooling broadly supplemented by that of the engineering college.

This idea that the difference between the machinist and the engineer is a difference of degree and not of kind is radically opposed to the prevailing theory of technical education. The modern idea of technical education is that it is provided for a different kind of a worker than the machinist, that the engineer does not need the machinist's experience, and that the machinist does not need to know the underlying principles. This is in deadly conflict with the theory upon which this paper is founded—that the logical development is from the machinist by the steps of technical education to the engineer. I would develop more theoretical knowledge and skill in machinists, and in certain individuals of this class who show, by natural selection, a promise of higher things, develop in these few a difference of degree until a well-rounded engineer is the result. The machinist needs as much of the underlying principles as he is capable of getting, and the engineer as much of machine-shop practice as is necessary to enable him to do the work himself. For if he cannot do it it is not likely that he will know how to do it, or how other men should do it. If the foreman cannot take the place of the machinist he lacks something as a foreman. If the mechanical engineer cannot take the place of the foreman and machinist he cannot most effectively engineer the work.

Elimination Should Begin at the Bottom.

The frugal New England father used to say, "My son, look out for the pennies and the dollars will look out for themselves." It seems to me almost as if we may say, "Look out for the American machinist and the mechanical engineer will look out for himself." Among a large number of well-trained and well-educated machinists we are sure to get one or more expert engineers, men who will stand out against the sky as the few tall trees in a forest. These are engineers born, and not made. I repeat that selection and elimination in the system for the education of machinists, foremen and mechanical engineers should begin at the bottom and proceed upward rather than as is now the case with the technical school, beginning at the top and proceeding downward, dropping large numbers because they are failures.

When this fundamental principle is fully understood educators will so modify the technical schools by having graded courses, without abandonment of the highest, best and most scientific courses for those needing it, that the great needs of the many for training for mechanics will be met to a large extent, or, failing to make this necessary modification, new schools must be organized.

There will always be a field for the higher engineering schools in connection with this scheme. The success of the technical school, which is everywhere recognized, and which I believe is largely responsible for our present industrial and mechanical supremacy, is due to its results in supplying the demand for scientific engineers. I have already distinctly emphasized that there is a field in the higher realm of scientific engineering which should foster and impart such knowledge, and that all professional engineers need not be the product of such a school system as the half-time school.

If some preferred to enter the profession directly through the engineering college, and to enter into competition with the few who, through their native fitness and energy, come up through the real and thorough experience of the school shop, the engineering school would furnish the opportunity. It is claimed for the proposed system that the few who are sure to come up from the rank and file of the many, who would have elementary educational training superior to any other course, would eventually largely constitute the pupils of the higher engineering colleges, whose work would be consequently elevated, from the fact that the graduates from the half-time schools will be the choicest and the fittest, and would come to the engineering college in many ways much better fitted for professional work.

While there might possibly be room for all the technical schools there are to-day conducted on professional engineering lines if other schools were formed to lead up to them, at present the whole system is top-heavy. If two-thirds of the technical schools of to-day would lower their standards of entrance and adopt the principles such as are advocated for the half-time school, somewhat modified, of course, for their special requirements, they would be crowded with ambitious young men, and the need for technically trained workers would begin to be filled. The one-third remaining could devote their attention to a class of material selected for them from such schools and to those who desired to enter the profession on the air line.

The Manufacturing Engineer.

Professor Hutton has forcibly called attention to an important change that has taken place in the condition of the professional engineer, which, I think, supports the underlying principles of this paper. He shows that the consulting engineer is being engaged by the seller instead of the buyer, and that the future engineer is to be a manufacturing engineer. This fact emphasizes the inseparable connection between the engineer of the future and the machine shop and machinist. Professor Hutton also shows that the present tendency of all manufacturing to center under large heads or corporations is likely to do away entirely with the demand for the so-called professional consulting engineer and his office, corresponding to that of the lawyer. If educators are prompt to adjust the course of training to this imperative demand, great changes and great improvements will be made, and such schools as the half-time school will take an effective co-operative part in industrial education.

Character of the Half-Time School.

The proposed half-time school is not a trade school simply; it is much more, because, while it proposes to do more, and not less, in the trade work of the shops, it proposes to do much more than has ever been attempted in a trade school in the line of mental discipline and education.

It is hoped that my foregoing remarks regarding the importance of the machinist and his business will make my position clear to those who think, like Professor Shepard, U. S. N., who says in his discussion, "it appears to me that the author attaches undue importance to the machinist." On the contrary, I have a strong feeling that a great danger lies in attaching too little importance to the machinist. I think a mistake in the direction of this danger will be as fatal to the highest interests of American industry as any mistake that is likely to be made. Our mechanical engineerers are not likely to degenerate, or to be found wanting when standing among the engineers of the world, but as yet there is no commensurate provision made for our machinists. A broad, high education of the American machinist is the best and surest possible support to the highest position and rank of our professional mechanical engineers. I am afraid that this truth is sometimes overlooked in our engineering colleges, and is not comprehended by professors. Scientifically educated men and professional educators can afford to be very broad in defining their work and in dealing with those of us who are mechanics and manufacturers.

We hear considerable talk about the advantages of "exercises" over real shop work. There is an advantage in the exercise system in the ease and convenience to the school and the teachers, but a disadvantage to the student. One of the great advantages of real shop training for a young man is the development of a ready ability to choose between methods and to select wisely the best means. And no two cases are just alike. One method contracts and narrows the boy and the other develops him into a man of resources. The instructors who advocate the exercise plan seem not to comprehend that shop instruction does not consist in cutting of chips and shavings only, but in giving experience in real manufacturing. This can be done if you will only put the boy into real manufacture of machinery, with suitable teachers—teachers who will guide just the right amount and let the boy go forward and upward.

A school shop must be a good shop, with common-sense management, thoroughly practical, productive and commercial. The motto "The best is none too good for a boy" must always be kept in sight. The teachers and instructors and lecturers in the school shop should be the best machinists, the best machine designers, the best engineers and the best educated and cultured gentlemen that America affords. The school shops can afford to have the best, because such men will make it pay best and turn out the best graduates.

I find that the paper did not make clear to every reader that the proposed shops of the half-time school are entirely independent of all school boards and all other control, except that of the private corporation, organized and chartered solely to conduct the shops upon a commercial basis for the education of young men, and that this shop constitutes only one-half of the half-time school. The other half of the half-time school is to be conducted and controlled by the public school board similar to the high school. It is believed that any school board will favor and co-operate in their part of the half-time school, because it involves no serious change in the present high school, except to slightly modify the course of study and the hour plan, so as to accommodate this class of boys, who elect to spend half of their time each week in the school shops. The school board canont object on the ground of expense, because, as regards both room and teaching force, there is much in favor of the half-time system proposed. By the alternating of pupils from the shop to the school room double the number of pupils can be accommodated. I find that advanced educators are heartily in sympathy with such an adjustment, and where it is understood have unanimously admitted its practicability. Furthermore, a general public feeling is developing that we are having too much book and too little work in our school system.

In reply to the objection to my proposition to save to the student much that is now lost, or worse than lost, by long vacations, on the ground that it is impractical, I wish to call attention to the fact of the great success of summer or vacation schools throughout this country for the past ten years. This is the best and strongest evidence that the old long vacations are not necessary or desirable, if advantage is properly taken of the virtue of change of work, rather than entire cessation of work. Another strong evidence in the same direction comes from the fact that progressive men, such as Dr. Harper, adopt continuous teaching with success, as, for example, at the University of Chicago.

In regard to the criticism and lack of faith in making such a shop as I advocate financially successful, I simply refer to the history of the 28 years' experience at the Worcester Polytechnic, published in the original paper, which proves that point beyond any reasonable doubt. I do not, however, insist that financial success is necessary to the scheme any more than it is in any other system of education; I simply submit that it is practical and possible, and with the right conduct the tendency will necessarily be in this direction.

I submit that no time or condition since the dawn of educational history has offered such an opportunity for important results as the present offers to those who can make educational provision for the needed training of the American mechanical workman. Upon this training depends very largely our future position among the industrial nations. This is the hopeful remedy for the most grievous class distinctions and strikes at the foundation cause of all labor difficulties.

ASPHALT PAVEMENTS IN LONDON have been recently reported upon by Mr. D. J. Ross, Engineer to the City of London. Nearly all the main streets in the City are laid with asphalt, and in some of the minor streets this pavement has lasted for 30 years. On Holborn Viaduct it has been down 17 years; in London Wall, 20 years, and in Lothbury for 23 years. In the Poultry the asphalt pavement was down 19 years before it needed repairs, and in Princes Street its life was 22 years. Mr. Ross recommends asphalt instead of wood block for the new pavement of Holborn Viaduct. As to wood pavement, he found the deal block superior to the hard wood tried, though this deal block pavement must be relaid every five or seven years.

THE MANUFACTURE OF ALCOHOL FROM ACETYLENE.

Considerable interest has been manifested recently in regard to the synthetic manufacture of alcohol from acetylene, and fragmentary accounts of processes have appeared in various technical journals and in the United States consular reports. These accounts differ somewhat in regard to the exact nature of the processes employed and greatly in regard to their commercial practicability. In view of the absence of exact information on the subject, the unfavorable opinions of some of the authorities quoted below may justly be considered as not entirely conclusive, and it is still to be proven that a process cannot be perfected that will be commercially profitable at the prevailing prices of the elements entering into the manufacture of the finished article.

The Villon method of making alcohol is described by Dr. George H. Benjamin in a recent number of the "Electrical Review," from which the accompanying diagram is taken. He states that ethyl-alcohol is largely used in Russia as a fuel for motor vehicles, being made by this process at a cost of only 8 cts. per gallon. The method of manufacture is as follows: Calcium carbide is first produced in the usual way by subjecting ground quick-lime and coke in intimate mixture to the electric arc. The calcium carbide is decomposed with water, forming acetylene gas. This gas is then allowed to bubble through and is absorbed by a reducing salt of the general type of chrome sulphate of the protoxide variety, a double sulphate of chromium and ammonia being an excellent mixture. The strength of this solution is such that in the absorption of the acetylene a quantity of hydrogen, by weight equivalent to about 10% of the acetylene, is generated in the reaction. The general effect of the reaction is the formation of ethylene gas and the reduction of the chromium oxide to a lower type. It is found advantageous to heat the solution of the chromium salts to a temperature of, approximately, 40° C., though it is not essential. The reducing salt is brought back to its former condition by the action upon it of nascent hydrogen, which is most conveniently produced by some electrolytic arrangement. The ethylene produced is led to an absorption apparatus consisting of a series of cells filled with sulphuric acid. The ethylene gas bubbles through the cells and is finally totally absorbed. The combination formed is hydrogen-ethyl-sulphate. To this is added about one-third its weight of water and the whole is heated, the effect being that the hydrogen-ethyl-sulphate is decomposed, ethyl-alcohol passing off and being condensed in suitable condensers. After the ethyl-alcohol is distilled off, the fluid left in the retort is sulphuric acid which may be used again. The alcohol is said to be of extreme purity and naturally is not accompanied by the various other oils, ethers, etc., which are the by-products of fermentation and are encountered in the ordinary alcohol of commerce. In comparison with any petroleum product this fuel possesses great advantages of cleanliness and freedom from all disagreeable odor. It is stated that the price of carbide in Russia is $20 per ton.

While the above process appears to us to be quite feasible from a chemical standpoint, the prices given seem to be in error. A ton of calcium carbide would give rise to 1,440 lbs. of ethyl-alcohol, or about 225 gallons. At 8 cts. per gallon this would be worth $18.

It is but just to add, however, that the cost of carbide for such purposes might be very much lower than the market price. The only "raw materials" required in the process are coke, fuel and power. The lime remaining after the reduction of the calcium carbide may be passed through a kiln and used in the making of more calcium carbide. Moreover, there need be no charges against the latter for transportation, which is very expensive as the carbide cannot be exposed to the air for a long time but must be enclosed in air-tight cylinders. The amount of fuel required, except that to be used in the above proposed lime kilns, would be insignificant, and it might be replaced by electric heating. The great desiderata in this process would be cheap coke and cheap power. The cost of plant and the cost of labor are difficult to estimate off-hand.

The following descriptions and discussions are taken from the advance sheets of Consular Reports. Mr. John K. Gowdy, United States Consul-General at Paris, writes as follows:

Mr. Berthelot, of Paris, France, was the first to make a synthesis of alcohol from a purely theoretical point of view. The acetylene is transformed into ethylene. This gas is brought into contact with mercury with concentrated sulphuric acid, then shaken briskly for three-quarters of an hour, or about 3,000 movements; the results being ethyl-sulphuric acid or sulphovinic.

$$C_2H_4 + H_2SO_4 = C_2H_6SO_4.$$

This acid is diluted with water from eight to ten times its volume, and then undergoes distillation. The sulphuric acid reforms and a mixture of water and alcohol passes off.

$$C_2H_6SO_4 + H_2O = H_2SO_4 + C_2H_6O.$$

The alcohol is extracted in a second distillation by the use of carbonate of potassium.

The sulphuric acid is thus regenerated, but diluted with water. It cannot, therefore, re-enter in the manufacture until it has been brought back to its primitive concentration.

The "Moniteur de l'Industrie du Gaz" gives as follows the speculative calculation of the cost price of alcohol by this process to obtain 100 liters (22 gallons) of alcohol: Calcium carbide, 139.13 kilograms (306.72 lbs.); hydrogen, 4.35 kilograms (9.59 lbs.); concentrated sulphuric acid, 213.05 kilograms (469 lbs.). The price of calcium carbide in the above is calculated at 10 centimes (1.93 cts.) per kilogram. This is evidently a price much too low. Twenty centimes (3.86 cts.) is nearer the cost price, providing that the carbide and the alcohol are made in the same factory; otherwise, the calculation should be 40 centimes (7.72 cts.).

Upon leaving the producing apparatus the ethylene passes into a ball-shaped glass containing sulphuric acid and is transformed into ethyl-sulphuric acid. This, once formed, runs into a decanter, where it is subjected to distillation. The alcohol afterwards passes into a tube containing chips of copper or some other substance for drying and purifying; it then condenses in a receptacle.

The difficulty of obtaining a complete transformation of acetylene into ethylene and afterwards into ethyl-sulphuric acid is very evident.

There is also another process possible. [illegible] ad of shaking the acetylene directly over the hydrogenating mixture. The direct methods given above can be employed. [illegible] e of the inventor, viz., absorb the gas by a dissolution of protoxide of chromium in ammonia, added with chlorhydrate of ammonia. The peroxide of chromium formed will be then reduced to protoxide by the iron and zinc acting on the sulphuric acid.

It is also proposed to transform acetylene into biniodide of ethylene $C_2H_4I_2$ by the action of a watery solution of iodhydric acid. this liquid, which boils at 175° C., can be transformed direct into alcohol by the action of water, zinc, and oxide of zinc 10 to 15 weights of water heated under pressure 140° to 150°.

$$C_2H_4I_2 + Zn + H_2O = C_2H_6O + Z[illegible]$$

The liquid cooled and submitted to distillation gives pure alcohol. The iodide of zinc is thus transformed into iodhydric acid. Acetylene can also be transformed into ethylene and ethylene into ether iodhydric C_2H_5I by heating to 100°C. with concentrated iodhydric acid. This ether, slightly heated with acetate of silver, produces acetic ether.

$$C_2H_5I + C_2H_3AgO_2 = C_2H_8\ (C_2H_5)\ O_2 + AgI.$$

Finally, the acetic ether, saponified by the watery potash, produces alcohol and acetate of potassium.

$$C_2H_3\ (C_2H_5)\ O_2 + KOH = C_2H_6O + C_2H_3KO_2.$$

The iodide of silver and the acetate of potash obtained as by-products can no doubt be employed for some chemical purpose.

Among these various methods, some are of great value to demonstrate in the laboratory a synthesis of alcohol, but at present none of the methods can actually be employed for industrial or manufacturing purposes at a remunerative cost price. It is indisputable, however, that if one of these methods could be practically applied, it would produce a revolution in the alcohol industry.

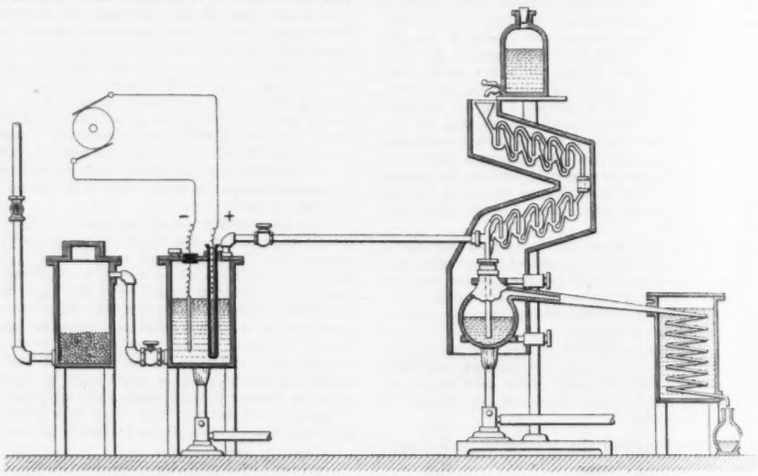

DIAGRAM OF APPARATUS FOR MAKING ALCOHOL FROM ACETYLENE.

Estimated at 20 centimes (3.86 cts.), we have as follows:

Detailed Expenses.	Total cost.
140 kilograms (308.64 lbs.) of carbide at 20 centimes per kilogram (3.86 cts.)	$5.40
4.35 kilograms (9.59 lbs.) of hydrogen at 3.50 francs per kilogram (67.5 cts.)	2.94
Absorbent salt to regenerate the sulphuric acid	.29
Labor and fuel	.29
Wear and tear of material	.29
Rent and general expenses	.96
Total	$10.27

As alcohol is at present worth about 29 to 30 francs ($5.59 to $5.79) the hectoliter (26.417 gallons), this cost price is much too high, as it would be also if the carbide were diminished one-half in price.

The application of this method is not without its difficulties from a practical point of view. The following process has also been proposed:

To use the apparatus invented by Sainte-Claire-Deville for the intermittent preparation of hydrogen, which is composed of two bottles tubulated near the bottom and connected by a rubber tube. In one of the two bottles, which is hermetically closed, a stopper furnished with a tap is placed. A mixture of zinc and calcium carbide in the proportion of 2.5 kilograms (5.5 lbs.) of zinc for 2 kilograms (4.4 lbs.) of carbide, and not zinc, as in the preparation of hydrogen, is used. The other bottle, which is open, receives the acidulated water, containing 3.2 kilograms (7 lbs.) of sulphuric acid to 5 liters (1.1 gallons) of water. Upon the removal of the last bottle, the acidulated water comes in contact with the zinc and the calcium carbide at the same time; the hydrogen and the acetylene thus formed combine and produce ethylene, which passes out by the tap. This tap being closed and the open bottle lowered, the liquid is driven back by the gas which is produced and soon ceases to act on the zinc and the carbide.

The following is quoted from the "Handbuch der Spiritus Fabrikation," by Dr. Max Märcker:

Olefiant gas, ethylene, conducted through sulphuric acid, will result in ethyl-sulphuric acid ($C_2H_6HSO_4$). If then diluted with water, the reaction or counterformation will produce sulphuric acid and alcohol. As ethylene gas, through distillation, is produced from coal, it being the illuminating part of coal gas, we can indeed make claim that alcohol can be produced from coal. The result of the production of this kind of gas being so meager and the cost so high—also the work so intricate—the alcohol industry has nothing to fear from the competition of coal for this purpose.

The "Metall Chemische Revue," some time ago, published the following statement:

Lately, it has been found that common low-grade spirits can be changed into absolutely pure alcohol in a simple manner by means of calcium carbide. The contact of spirits which contain water (diluted spirits) will produce acetylene gas, through which the water will be replaced partly and partly combined with chalk. The action can best be proven by placing some powdered calcium carbide in a bottle, and then adding spirits containing

more ... of water. **The latter solution should weigh ... as much as the powdered calcium carbide. (... words, the proportion in regard to weight is 75% ... containing more than 10% water and 25% powder... carbide.)**

The ... development of gas will soon cease, after which ... should be shaken every two or three hours ... following half day. Let the bottle stand quiet for ... 12 hours, after which the liquid can be distilled ... to be a 100% alcohol, free from any water.

There ... American patent, No. 608,652, for the prod... of ethyl-alcohol, granted to Frederick R. ...ert, Jr., of New York, and an English patent, No. 1,208 (1898), belonging to the Alcohol-... rate, of London, England.

RUN-OFF OF THE SUDBURY RIVER DRAINAGE AREA, 1875-99, INCLUSIVE.

By Charles W. Sherman, Assoc. M. Am. Soc. C. E.*

The amount of water yielded by Sudbury River has been so carefully gaged for a considerable period, and the results are so universally accepted, that awards for diversion of water have been, in many cases, based on computations from these yields. In Engineering News of March 7, 1895, there was given a table showing the yield of the watershed for the 20 years 1875-1894, inclusive. As the year 1899 completes the quarter-century since these gagings were commenced, and as these figures are so generally used, the yield by months of one square mile of the watershed for the 25 years, 1875-1899, in cubic feet per second, is submitted herewith, as Table I.

For the benefit of those readers who are not familiar with this watershed, it may be said that since 1875 it has been one of the principal sources of Boston's water supply. The surface is generally hilly, and contains water surfaces which have been increased from time to time from 1.9% in 1875 to 6.5% in 1899, of the area of the watershed. The measurement of the run-off consists of three parts, which may be broadly classed as measurements of water used, water wasted, and water stored. The "water used" is the amount drawn for the supply of the district, and is gaged in the aqueduct. The "water wasted" consists of the quantities passing the lowest dam over the crest or through the waste gates, both of which amounts are easily gaged. "Water stored" may be either plus or minus, and is obtained from tables of capacity and records of the elevations of water surfaces of the reservoirs. The resulting yield is, therefore, corrected for the effect of the reservoirs, except as the increased area of water surface results in increased evaporation.

The average yield of the watershed for the 25 years 1875-1899, inclusive, expressed in the various forms in which it may be used, is given in Table II.

As is well known, the summer and fall of 1899 were very dry, and in fact the records show smaller yields, for periods ranging from one to eight months, than ever before since the record has been kept. The dryest month of 1899, August, shows a MINUS YIELD of 0.054 cu. ft. per sec. per sq. mile. This apparently impossible state of affairs is readily explained when we remember the large amount of water surface and the consequent excessive evaporation. Bearing in mind, too, that these water areas are much larger now than in 1880 and 1883, the years which until now have shown the smallest yields, and that other conditions have changed somewhat, it appears that a comparison of the records does not show in which year the dryest period really occurred.

An attempt has been made to compute what the yields of various periods of the years 1880 and 1883 would have been had the same conditions obtained then as in 1899. By this adjustment the yields of the wet months are increased, and those of the dry months decreased. The results are as follows:

(Yield in millions of gallons per day per square mile.)

Period.	1880. Adjusted to conditions existing in 1899.	1883. Adjusted to conditions existing in 1899.	1899. Records.
Dryest 5 months....	0.072	0.061	0.051
" 6 "	.086	.082	.093
" 7 "	.103	.106	.111
" 8 "	.142	.206	.162
" 9 "	.183	.305	.232

*Assistant Engineer, Metropolitan Water Board, Boston, Mass.

TABLE II.—Average Yield of Sudbury Watershed, 1875 to 1899, Inclusive, Variously Expressed.

(Area of watershed, 75.2 sq. miles.)

Month.	A square mile.—Cu. ft. per second.	A square mile.—Million gallons per day.	Rainfall.—Collected, ins.	Rainfall.—Per ct. collected.	Rainfall.—Total. ins.
January.....	1.937	1.252	2.233	51.6	4.33
February.....	2.904	1.877	3.050	71.7	4.26
March.....	4.489	2.901	5.175	117.4	4.41
April.....	3.124	2.019	3.485	107.5	3.24
May.....	1.680	1.086	1.936	58.1	3.33
June	.735	.475	.821	28.0	2.93
July	.305	.197	.352	9.3	3.77
August.....	.478	.309	.551	13.3	4.16
September.....	.376	.243	.419	13.0	3.23
October	.829	.536	.956	21.9	4.37
November.....	1.474	.953	1.645	39.0	4.22
December.....	1.612	1.042	1.859	51.9	3.58
Year.....	1.655	1.070	22.482	49.1	45.83

OPERATING ECONOMIES IN CENTRAL STATION PRACTICE.*

By W. L. Abbott.†

In every central station there grows up a characteristic system of practices, good, bad or indifferent, due partially to peculiar environments and partially to the ability of the operating force. Through natural selection the best of these practices are gradually crystallized and become the unwritten code of rules for the direction of the internal affairs of the station. Some of these practices, while the very best for that station in which they originate, may prove very unsatisfactory when transplanted into other stations; yet it is largely due to the cordiality with which central station managers impart to and adopt on trial from each other new methods that the present rapid improvements in operating details are being made.

The saving and renovating of waste and oil is an ever-present and variously handled question in all stations. Some simply use the waste until it is oil soaked and then burn it under the boilers; others go to the other extreme and use wiping towels, which are carefully saved, washed and used over again. We favor a middle course, using a good quality of waste, first on the finer parts of the machinery and then for coarser work, after which it is put through a washer consisting of a train of rolls, over which hot water is running. This extracts nearly all of the oil and much of the dirt. The oil and water are caught in a receptacle, the oil separated and passed to the oil purifier and the waste is put into the drier. This drier consists of a sheet-iron box 30 ins. square and 6 ft. high, filled with shelves, one above another, made of wire netting and spaced about 10 ins. apart, for the reception of waste to be dried. The case stands a few inches from the floor, and in the bottom, which is open, is a steam coil. A door occupies one full side, and to the top is connected an 8-in. galvanized pipe leading to the boiler breeching for the purpose of inducing a draft. The whole thing is quite simple and inexpensive, yet it will thoroughly dry a charge of 200 lbs. of damp waste in a few hours. This dry waste is somewhat harsh and knotty, but has better absorbing qualities than new waste, and we use and wash it over and over again.

The oilers are allowed but ¾ lb. of new waste on a shift to keep a 1,200 HP. engine clean, but they are allowed all of the washed waste they want. In separating oil from waste it is difficult to say which is the by-product and which the direct product, as from 100 lbs. of oily waste we get 40 lbs. each of oil and waste, and one product is about as valuable as the other.

The amount of engine oil used at our Harrison St. station has been reduced to the lowest possible minimum, I think, as it amounts to only about 50 gallons of new oil each month. This is obtained by catching and refining all the lubricating oil used on our machinery, which is quite readily possible on vertical engines. The drains from our crank pits are carried down into the oil refiners, and the oil from the waste is all saved and put through a process which makes it better than new oil. This may sound like an exaggerated statement, but I will explain later on why it is better than new oil. I have spoken of oil refiners and of refining the oil, instead of filters and filtering the oil, for the reason that we have no filters and do no filtering, but purify the oil by settling and boiling. Our refiners consist, essentially, of three upright cylindrical tanks, the first of which receives the oil from the engines mixed with cylinder drips and water from journals, etc. In this tank, which is half full of water and half full of oil, the water and oil separate. The water goes to the bottom, where it is drawn off through a trap. The oil goes to the top and is drawn off through an overflow leading to the bottom of the second tank, in which is a steam coil under a pressure of about 100 lbs. This is for the purpose of heating the oil up to about 250°, at which temperature the water is driven off in the form of steam.

Owing to the surface tension of the oil around the small globules of water held in suspension, the water will not vaporize at a lower temperature. This tank is of such a capacity that the oil is about two days in passing through it, and it then goes to the bottom of the third tank, where it is allowed to stand about the same length of time and where any sediment it may contain will be deposited. From the top of the third tank the oil overflows into a large storage tank, where it is kept until drawn off to be used. Few of those who have not looked into the matter would realize how much water will be absorbed and held in suspension by oil which contains a small trace of animal matter and how difficult it is to break up the combination once it is formed. Those of you who operate oil filters may have sometimes wondered at the accumulation of grease in them, this grease being a soft, jelly-like substance of the consistency of warm lard, or perhaps even thicker. This grease is no more than a combination of mineral oil, a small trace of animal oil and about 40% water. If it were placed in a vessel and heated to about 250°, the water would be driven off (perhaps with explosive force if heated too rapidly, but if the work is carefully done the water can be separated), and what is left would be the best kind of lubricating oil, containing a small trace of animal oil and in our case all the cylinder oil from which the animal oil is derived. It is the mixture of the cylinder oil with the engine oil which gives it its heavier body and better lubricating qualities. The oil which is expressed or washed out from the waste apparently contains more cylinder oil than that which comes from the engine drains, and on this account those who throw away their waste not only lose the waste, but the richest part of the oil which is contained in it. That this amount is considerable will be seen from the fact that from every 100 lbs. of oily waste we get about 40 lbs. of clean waste and 40 lbs. of oil.

The question of cylinder lubrication was once a very perplexing one for use, but after studying and experimenting we settled the question in such a way that it has not been open for several years. We had great trouble with cylinder oil, and had difficulty in finding an oil which would lubricate all of the cylinders of our triple-expansion engines from one lubricator. We have not found such an oil and do not expect to. We could find an oil which would lubricate the high-pressure cylinder, and we could find an oil that would lubricate the low pressure, but we could not find a combination which would lubricate all of the cylinders perfectly. We have, therefore, adopted an oil which will lubricate the high-pressure cylinder excellently and the intermediate cylinder moderately well, while the low-pressure shows only a slight trace of oil. As there is no cutting or scratching in the low-pressure while it runs dry, and as the high-pressure cylinder makes a prompt and vigorous protest if allowed to run dry for a few moments only, we have adopted the

*Abstract of a paper read at the annual convention of the National Electric Light Association, at Chicago, May 22.

†Chief Operating Engineer, Chicago Edison Co.

TABLE I.—Run-off of the Sudbury River Watershed for the Twenty-five Years, 1875 to 1899, Inclusive.

(Area of watershed is 75.2 sq. miles. Cubic feet per second per square mile.)

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	For year.
1875.....	0.159	2.315	2.482	4.718	1.838	1.346	0.497	0.612	0.321	1.000	2.015	0.903	1.504
1876.....	0.995	2.116	6.862	5.094	1.761	0.343	0.283	0.627	0.285	0.361	1.683	0.702	1.756
1877.....	1.019	1.469	7.448	3.703	2.153	0.924	0.312	0.187	0.092	0.977	2.193	1.995	1.878
1878.....	2.800	3.814	5.426	2.516	2.158	0.782	0.199	0.736	0.249	0.799	2.619	4.916	2.246
1879.....	1.083	2.647	3.605	4.821	1.723	0.640	0.243	0.611	0.218	0.109	0.318	0.716	1.383
1880.....	1.733	2.765	2.126	1.808	0.796	0.271	0.273	0.184	0.124	0.157	0.318	0.271	0.895
1881.....	0.642	2.392	6.195	2.392	1.493	2.070	0.428	0.229	0.305	0.287	0.611	1.199	1.515
1882.....	1.920	3.718	4.392	1.342	1.998	0.818	0.133	0.086	0.474	0.463	0.324	0.457	1.334
1883.....	0.518	1.598	2.492	2.088	1.450	0.464	0.178	0.122	0.141	0.288	0.317	0.299	0.824
1884.....	1.540	4.397	5.857	4.415	1.594	0.644	0.346	0.397	0.068	0.129	0.271	1.431	1.747
1885.....	1.910	2.095	2.433	2.808	2.067	0.659	0.096	0.372	0.187	0.519	1.822	1.816	1.393
1886.....	2.260	7.428	3.185	3.013	1.114	0.314	0.179	0.146	0.182	0.225	1.041	1.578	1.682
1887.....	4.006	4.377	4.437	4.053	1.561	0.640	0.178	0.331	0.172	0.294	0.570	0.995	1.785
1888.....	1.629	3.011	5.009	4.093	2.526	0.652	0.182	0.587	1.786	3.093	4.267	4.708	2.626
1889.....	4.305	1.850	2.071	2.182	1.361	1.011	0.980	2.216	1.274	1.903	3.003	3.467	2.140
1890.....	1.941	2.366	5.636	2.900	2.114	0.878	0.166	0.204	0.708	3.515	1.879	1.541	1.989
1891.....	4.669	5.393	6.891	3.709	0.901	0.639	0.231	0.252	0.314	0.325	0.472	0.842	2.034
1892.....	2.893	1.459	3.025	1.348	1.947	0.662	0.331	0.433	0.355	0.195	1.079	0.750	1.209
1893.....	0.671	2.386	5.021	3.288	4.461	0.680	0.244	0.280	0.167	0.343	0.493	1.232	1.604
1894.....	1.072	1.533	3.463	2.538	1.299	0.648	0.249	0.324	0.231	0.579	1.293	1.108	1.192
1895.....	1.900	0.837	3.728	3.892	0.984	0.269	0.357	0.354	0.158	2.134	4.296	2.757	1.782
1896.....	1.677	4.140	5.933	2.312	0.557	0.617	0.147	0.088	0.600	0.916	1.020	1.017	1.576
1897.....	1.307	1.651	3.908	2.344	1.416	1.488	1.018	0.914	0.282	0.145	1.407	2.451	1.533
1898.....	2.535	4.676	4.029	2.831	1.927	0.820	0.357	1.712	0.571	1.795	3.073	2.783	2.244
1899.....	3.541	2.137	6.507	3.900	0.790	0.102	0.030	—.054	0.145	0.179	0.474	0.340	1.506
Avg., 1875-99...	1.937	2.904	4.489	3.124	1.680	0.735	0.305	0.478	0.376	0.829	1.474	1.612	1.655

oil which will give the best results in the high and let the low be content with what it gets.

The results of our experiments have convinced us that the only oil to use in a non-jacketed cylinder, where it would come in contact with very wet steam, is one which is very highly compounded. It must also be an oil of a high fire test, and the reason why it does not lubricate the low-pressure cylinder as well as the high is that the temperature of the steam in the low-pressure cylinder is so low that the oil will not remain atomized in the steam, but washes down and combines with the water of condensation which has formed in the other two cylinders, and passes through the low-pressure cylinder in an emulsion with the water. To prove this theory I have tried the plan of mixing a cylinder oil of a high grade and high flash test with a light oil of low flash test, and feeding it through one lubricator through all three of the cylinders. The result shows a fair trace of oil on the walls of the low-pressure cylinder, and we ran our engine with this kind of cylinder lubrication for several months, but finally decided that the best results for the entire engine were obtained with that oil which gave the best lubrication in the first cylinder. We now use a heavily compounded high fire test oil fed into the steam pipe near the throttle. A gallon of oil so fed will give good lubrication for a 1,200 HP. engine for 12 hours. I have seen a compound engine of this capacity fed at the rate of nearly a gallon an hour without obtaining satisfactory lubrication, the whole trouble lying in the fact that the oil was not adapted to the particular conditions under which the engine was working, and I think this may account for the unmeasured praise or unstinted abuse which different brands of good oil receive from different engineers, and I think, furthermore, that the difference between a good oil and a poor oil made from high fire test stock lies almost wholly in the amount and kind of compounding.

In arranging an operating force and the pay-roll of the central station the superintendent should aim to get the maximum of results with the least expenditure of money and still to keep everything harmonious. To do this he should carefully arrange his force so that he will at all times have men enough to take care of the amount of work on hand and at no time have a surplus of help over what is required to take care of the work to be done. His scale of wages should also be carefully graded, so that the men doing the same class of work should receive the same pay, and that the rate of pay to the different classes of workmen should be in proportion to the skill, responsibility or manual labor required. Further than this, a considerable saving in money can be made by paying the men partially in hopes and promises. By this I mean to have a well-defined line of promotion, each man knowing his position in that line, and that his chances for promotion depend upon his ability, fidelity and length of time in the service. Any really good, ambitious young man is ready to begin work at the bottom of the ladder, and will work contentedly along on small wages if he is assured that the promotions to come will be awarded upon the above terms, and not by favoritism. The most demoralizing and disorganizing practice that can be introduced into a central station is to put a new man, the relative of some official, or the friend of some politician, into a desirable position over the heads of equally good men who have borne the drudgery and hard work of inferior positions, hoping and expecting that when there was a vacancy in a better position they would have the preference.

In many stations the force is divided into a night gang and a day gang, but I never thought this well adapted to central station work. The hours are too long, and it does not give the best distribution of labor, the number of men in the station not varying according to the load. The practice which we instituted several years ago of bringing the men on one or more at a time an hour or so apart and letting them off in the same way can be made to exactly meet the requirements of an uneven load, and enables us to rotate the different men of the same class through all the different shifts during the course of one or two months, thus making the work and the hours of all exactly alike in the cycle. At the end of each week the schedule is made up for the week to come for each of the different classes of operatives interested, and this is posted on Saturday night, so that as the men go off work on the following Sunday it is known what shift each will have during the coming week. These schedules are altered from week to week, increased or diminished as regards the number of men and changed in form to conform to the varying conditions of the load curve.

To illustrate by a set of December schedules: The problem to be solved is to arrange the schedule so that there will be at any time enough men for the work without having too many men around at other times, and, furthermore, to arrange the shifts so that none will be obliged to go home between the hours of 1 and 6 a. m. As we are not sure what the load will be from day to day, or a week ahead, we are obliged to provide men enough to take care of what we assume will be the reasonable maximum. With a little care and study, it is possible to arrange the schedule to very nearly meet the exact requirements. Take, for example, the firemen's schedule for the week commencing Dec. 18, 1899. We start at midnight with five firemen; two of these are relieved at 1 a. m. by two other men, who come on at that time. As the load from midnight to 6 a. m. is quite irregular, owing to the variable amount of charge required by the battery from day to day, we have rather more firemen on during this period for the amount of work done than we have during other times of the day. At 6 a. m. the load begins to pick up, and has nearly reached its morning maximum by 9 a. m. To take care of this our force of firemen is increased by one man each at 6, 7 and 8 o'clock, there being by that time eight men on, and the force is held at that number until 1 p. m. During this time several men come on and others leave, but the number at work remains the same. The slight drop of the load at noon is not followed by a corresponding change in the number of men, but it is taken advantage of as a slight breathing spell and gives the men an opportunity to clean fires and eat their dinners. After the midday drop in the load there follows a gradual rise until 4 p. m., which we anticipate by bringing a man on at 1 and another on at 2 p. m.. At 4 p. m. the load rises abruptly to the maximum shortly before 5 p. m. We provide for this by bringing three men out at 3 p. m. to get their fires in good shape ready for this hard pull, and, finally, at 4 p. m., the last man comes, which brings the total number of firemen on at this time of the day up to 14 men. After 5 p. m. the load gradually declines, until at midnight it is only about one-fourth as high. Owing to the way in which the men have been brought out their shifts are finished so that the force is automatically decreased in proportion as the load decreases, and we have during the day worked 21 firemen, who have altogether burned about 200 tons of coal, and have been so distributed that we have at all times had an excess of one or more men for the work, and none have been overworked.

The greatest possibilities for saving or wasting about a steam plant are undoubtedly in the coal pile, but the subject does not receive the consideration to which it is entitled. The average ambitious engineman will spend much time and care on his engine to be sure that the indicator cards are perfectly symmetrical, that the points of cut-off are equal, that the release is in time and that the compression rises to meet the admission in a smooth, rounded curve. This is proper and commendable; yet the same time spent in studying the conditions of combustion in his furnace might show him a way to make a saving in fuel fourfold greater than is possible in the final refinements of the indicator cards. A fireman whose wages amount to, say 20 cts. an hour, will burn during that time fuel costing 10 and 15 times as much as his wages. It would not be possible by any sort of driving to save half of the wages, but it is readily possible by properly watching and instructing the fireman to save double his wages in coal. In the first place, great care should be exercised in the selection of the coal to be used. I believe that the cheapest coal is that kind which has the greatest amount of combustible for the least amount of money, provided the furnaces are of the proper kind and ample in capacity to make the required amount of steam from them. The very cheapest kind of Illinois screenings, costing less than $1.50 a ton, will not have less than 10,000 British thermal units a pound, and the very best of Eastern lump, costing $4 a ton, will not have more than 14,000 British thermal units a pound. This means, then, that for equivalent heating qualities the cheapest screenings cost about half as much as the high-grade coal.

Having selected the coal, the next problem is how to burn it properly. It is commonly understood that 12 lbs. of air are needed to properly burn 1 lb. of coal. It is also commonly supposed that in practice about twice this amount of air passes through the fire, but just how much actually passes and under what conditions are the best results obtained are impossible to determine without making analyses of the flue gases. Fortunately, this has now become a very simple operation and one which can be performed and understood by anyone competent to take charge of a large boiler room. These tests often show the most surprising and disappointing results. The analyses are made to determine the percentage of carbon dioxide in the flue gases. Under perfect conditions it can run as high as 20%, but it is not unusual to find samples running as low as 2% of dioxide. This brings down the economy for two reasons: (1) the gas in the firebox is diluted with an excess of cold air and cooled down, and (2), the amount of gas being increased in volume passes the boiler more rapidly and does not give up so much of its heat. It is almost a paradox that within reasonable limits the more the gases are cooled down in the furnace by the admission of excess of air the hotter they will pass away from the boiler. The two causes of excess of air in the flue gases are running boilers on too light loads and careless firing.

In a station where the load is much higher for a few hours than during the rest of the day the tendency is to have too many boilers in service during the period of light load. The natural result is that the fires are run thin, the grates get bare in places, a great volume of air is drawn in and only a small portion of it comes in contact with the fuel Careless firing is always a flagrant waste of fuel. An engineman may be aware that he is not getting the results which his tests lead him to believe he should have, and yet in a boiler room where several men are working it is exceedingly difficult to fasten the blame on any one of them unless one tests the flue gases.

To follow intelligently the work of the individual fireman we have installed in our boiler room a device called the econometer, through which is induced a small current of gas from a boiler breeching. The weight of this gas, changing with its composition, moves a pointer across a dial, thereby indicating continuously the varying percentage of carbon dioxide in the flue gas. From this device are run individual pipes to the breeching of each boiler, and all is so arranged that samples may be drawn from several boilers and tested in a few minutes or a continuous test may be made of the performance of any one boiler. Readings taken from this instrument at regular and short intervals, when plotted, form a curve which is a very comprehensive record of the condition of combustion during the time of observation.

A SIMPLE METHOD OF CORRECTING THE SUN'S DECLINATION FOR REFRACTION.

In the new "Field Manual of Engineering Instruments," by Prof. L. S. Smith, of the University of Wisconsin, we find a method of making the above correction, which requires, in addition to a transit, nothing except a watch, dispensing entirely with the use of tables. In a private letter, Prof. Smith informs us that the method was devised by Prof. Comstock, of the University, but has been published only in a University bulletin. We print the instructions for this method as follows:

Having focussed the eye-piece and object glass of the transit so that a clear image of both the sun's disc and the cross wires can be seen on the screen held behind the eye-piece (a piece of white paper held by the hand will do for a screen), set the horizontal circle of the transit to read some integral ten minutes and point on the sun by the lower motion.

The earth's diurnal motion will carry the sun across the vertical thread of the instrument. Note the time on a watch to the nearest second when the sun is tangent to the vertical wire. Keeping the lower motion clamped, unclamp the upper and turn the alidade in the direction of the sun's movement, i. e., toward the west, and set the vernier to read the next ten minutes. Note again the time when the sun is tangent to the vertical thread. Also read the vertical angle to the sun. Then, if we call n the interval of time elapsed in seconds while the sun (really the earth) was passing through ten minutes of arc, and call h the vertical angle in degrees, the refraction d, in minutes, is given by the equation

$$d = \frac{2{,}000}{h.\,n}.$$

Experience in using this formula has shown that its maximum errors will not exceed 15″ when the sun is above 10° altitude, while its average error is less than half this amount. As the refraction correction, as ordinarily computed, is based upon average conditions of temperature and barometric pressure, seldom exactly realized in any given case the writer has not been surprised to find that results obtained by the use of the above formula are quite as good as those obtained from the more complicated and pretentious formulas and tables.

A still more accurate determination of the refraction can be made by the use of the following equation:

$$d = 100\,\frac{N}{n},$$

where d and n stand for same quantities as before, and N is obtained from the following table by entering it with the measured altitude of the sun as an argument:

h.	N.	Dif. for 1°.	h.	N.	Dif. for 1°.
10°	131		30°	36	
		9			1.4
15°	86		40°	22	
		5			0.9
20°	62		50°	13	
		3			0.6
25°	47		60°	7	
		2			0.4
30°	36		70°	3	

The altitude of sun need only to be observed to the nearest half degree.

The tabulated values of N correspond to a temperature of 50° F. and a barometric pressure of 30 ins. They may be adapted to any other temperature by diminishing d by 1% for each 5°, by which the temperature exceeds 50°, or by increasing 1% for each 5° below 50°.

This correction and the correction for variations of the barometer can usually be neglected. At great elevations, however, the barometric pressure becomes so much reduced that its variation must be taken account of, and this is done by diminishing d by 1% for each 300 ft. of elevation above the sea.

AN OVERHEAD TROLLEY LINE has at last found lodgement in the suburbs of London, and about June 15 two such lines will be in operation. This is the first time lines of this type have been built in that city.

BOOK REVIEWS.

LOGARITHMIC TABLES.—By Professor George William [illegible], of Cornell University. 8th edition. Ithaca, N. Y.: George W. Jones. Cloth; 6½ × 10 ins.; pp. 160. $1.00.

This collection of mathematical tables is quite complete [illegible] everything apt to be needed by the engi[illegible] student. The table of contents is as follows: [illegible] of the Tables; Four-place Logarithms; Four-[illegible] Trignometric Functions; Six-place Logarithms; [illegible], Weights and Measures; Addition-Subtraction [illegible]; Sines and Tangents of Small Angles; Natural [illegible] Logarithmic Trignometric Functions, 6 places; Nat[illegible] Logarithms; Prime and Composite Numbers; [illegible] Cubes; Square Roots; Reciprocals; Quarter [illegible] Bessel's Coefficients; Binominal Coefficients; [illegible] of Observation. The book is well printed and [illegible] To avoid straining the eyes the logarithms are [illegible] in blocks of five, and, instead of tracing the lines [illegible] across the page and down the columns the compiler may guide himself by correspondences of position in the blocks. We suggest that a book of this sort should be provided with a marginal index, especially when it contains as many different tables as the present one.

MONOPOLIES AND TRUSTS.—By Richard T. Ely, Ph.D., LL.D., Professor of Political Economy and Director of the School of Economics, Political Science and History in the University of Wisconsin. New York: The Macmillan Co. Cloth; 12mo.; pp. 278. $1.25.

The author of this book is one of the best known and most deservedly popular of American writers on economic subjects. The present volume is a rather brief discussion of a very large subject, a more exhaustive treatment of which the author promises in a work on "The Distribution of Wealth," now in preparation. After an extended discussion of "the limits of monopoly," Professor Ely concludes that, "so far as we now see, we have a large field belonging to monopoly; but, outside of this field we have another in which, under right conditions, competition is a permanent social force."

In the final chapter, "Evils and Remedies" are considered," and the author arrives at the conclusion that the great difficulty to be met and overcome in order to protect the public from the extortion of monopolies is to secure a better and more honest and efficient government throughout all its gradations from local to national. We quote as follows:

Whatever we do, we must recognize that social evolution has brought us problems which in their very nature are difficult. The question is, Which method in the long run offers the least difficulty and promises the most beneficial results—public control of private property in natural monopolies of the kinds under consideration, or public ownership and management of such natural monopolies? The evidence of a rapid shifting of public opinion manifested at the Chicago Trust Conference was most remarkable, and was to the author a great surprise. When, less than fifteen years ago, he began urging the superior advantages of public ownership and management of these monopolies, he found comparatively little sympathy. During the period that has intervened, however, there has been such a change in sentiment on the part of others—coupled, perhaps, with a slight lessening of ardor on his own part—that at Chicago he found himself standing among those who would be regarded as the conservative element, while those who have figured as opponents of governmental activity were predicting that we would have government ownership of railways sooner than the writer can anticipate.

Other remedies for evils and abuses due to monopolies proposed by Professor Ely are taxation, education, tariff reform, reform of the patent laws, and reform of corporation laws.

The author has devoted so large a share of his space to reviewing and discussing the various theories of economic writers upon the topics discussed that the book will interest the student and scholar more than the business man or the ordinary reader. More boldness and vigor in presenting and supporting his own views would have made the book more readable, and we believe also more influential as a factor in popular economic education.

We may note in conclusion that this volume is the first in a series to be known as "The Citizens' Library of Economics, Politics and Sociology." Prof. Ely will act as editor of the whole series, and the contributing authors will be selected to insure a thorough and up-to-date presentation of the principal topics in the field covered. Among the volumes of the series already arranged for is a treatise on "Municipal Engineering and Sanitation," by Mr. M. N. Baker, of the editorial staff of Engineering News.

REPORT OF THE COMMISSIONER OF EDUCATION FOR THE YEAR 1897-98.—Vol. 2. Containing Parts II. and III. Washington, D. C. Cloth; 9 × 6 ins.; pp. 1,281-2,640.

This interesting and useful public document deals first with child study in the United States, and treats of the scientific methods whereby teachers and investigators have tested, by answer to questions, by drawings, by muscular action, etc., the original condition of the minds of children, their conception of word pictures, their motor ability and imitative instincts. The results of these tests are carefully tabulated and conclusions are drawn from these tables. Succeeding chapters give recommendations upon the preparatory study of French and German; remarks upon university types and ideals; report on school statistics; the medical inspection of schools, in Boston, New York, Chicago and other cities; the Bible in schools and colleges; methods of instruction in agriculture; and consular reports upon European school systems. The legal provisions of the various states relating to the examination and certificates of teachers are elaborately set forth and discussed, and under the head of "Current Questions," reports are made upon coeducation, higher commercial education in Europe, compulsory attendance, child-labor and factory laws, corporal punishment, teacher's pensions, etc.

An interesting chapter is devoted to foreign universities and other institutions of higher education; and a chronological list of these is given, commencing with the Cairo school of the 10th century, and the special lines of instruction in each institution are briefly noted. Immediately following this is what may be called a detailed history of American institutions of higher education. But in this connection, it may be noted that the "statistics of technical schools" here given is a misleading headline. Only 43 institutions of this kind are named; and this list probably covers the technical schools having a separate existence. But we fail to find there the very important scientific schools connected with the Universities of Yale, Harvard, Cornell, Chicago, Pennsylvania, etc.; and no mention is made of the many agricultural and manual and training schools, which have courses which should properly come under the head of technical education. The technical schools omitted in this arbitrary list are included under other heads; but in such a manner that it is difficult, and in many cases impossible, to pick out the statistics relating to them alone.

Very full tabular information is given as to the 480 universities and colleges for men and both sexes in the United States, and for the 148 women's colleges and schools. Of professional schools, 875 are noted; including those devoted to the study of theology, law, medicine, dentistry, pharmacy and the training of nurses; the latter alone accounting for 377 in the total given. But in these lists, as well as in the statistical matter relating to agricultural and mechanical colleges, normal and high schools, trade and manual training schools, there is considerable difficulty in arriving at broad conclusions, as a number of them seem to be duplicated in the several lists. Under the head of commercial education in the United States the report begins with the "business" colleges first established 50 years ago, which until very recently practically confined the branches taught to book-keeping, penmanship, business forms and the calculation of percentages, etc. The demand for stenographers and typewriters caused other branches to be established; but nothing was done for the higher commercial education until the founding of the Wharton School of Finance and Economy, in connection with the University of Pennsylvania. The Universities of California and of Chicago have now similar courses of instruction, and a number of our colleges have much improved their so-called business courses. But that we are far behind European nations in methods of scientific business and commercial training is made very evident by the consular reports upon such schools, contained in this report.

HYDRAULIC POWER ENGINEERING.—A Practical Manual on the Concentration and Transmission of Power by Hydraulic Machinery. By G. Croydon Marks, Assoc. M. Inst. C. E. With over 200 Illustrations. London: Crosby, Lockwood & Son. New York: D. Van Nostrand Co. Cloth; 12mo.; pp. 360; $3.50.

This book is an excellent practical manual for engineers and students interested in the design and use of hydraulic machinery. It contains no more theory than is absolutely necessary to explain the subject, and no mathematics beyond a few simple equations (except in the chapters on turbines), but is full of useful suggestions for the designer. Chapters I. and II. treat of hydraulics and of the observed flow of water. Chapter III. discusses the pressures used in hydraulic machinery, classifying low pressure as being less than 200 lbs. per sq. in., medium pressure as from 400 to 1,500 lbs. and high pressure as from 1 to 10 tons per sq. in. Chapter IV. treats of the materials used in hydraulic presses, such as cast iron, steel, gun metal, etc. The elastic limit is discarded by the author as of no value in designing, since, as the author says, it can be raised at pleasure. We quote:

A steel or iron master who has to do with an engineer who has great faith in the elastic limit—and there are such engineers—has merely to watch his opportunity and apply a stress equal to the prescribed "elastic limit" before the inspector commences his test, and he will be sure of the bar passing the test as far as regards the "elastic limit."

The next chapter discusses "test load." The author divides working loads roughly into four classes:

(1) Perfectly steady loads; (2) ordinary loads, not perfectly steady, but nearly so, and perfectly steady loads applied to machines in which failure would involve considerable loss or annoyance; (3) loads applied with more or less but not excessive shock; (4) loads in which failure must result in danger to life or limb.

Types of the four classes of loads are given, and the allowable working load is stated to be four-fifths of the test load in class 1, two-thirds in class 2, one-third to one-half in class 3, and one-fourth to one-fifth in class 4, with a still larger margin of safety if frequent skilled supervision cannot be guaranteed. The strength of thick cylinders of cast iron is discussed, and a table of dimensions is given, deduced from successful practice which the author considers better than a "formula based on a defective theory." Sketches of proper and improper forms of cast cylinders are also shown. Chapter VI. treats of packings for sliding surfaces; Chapter VII. of pipe joints; and Chapter VIII. of valves. These are fully illustrated by sectional drawings, showing details of construction. Chapter IX. discusses "platform lifts," English for elevators. Much useful information for designers is contained in this chapter, but it is altogether too brief, only 42 pages, including many large cuts. It would be well if this chapter were greatly enlarged, and made to include some account of American practice.

Chapters X., XI. and XII. are devoted to workshop and foundry cranes, warehouse and dock cranes, and hydraulic accumulators. As only 30 pages are covered by these three chapters, including many large cuts, the treatment is rather too brief, but it is good as far as it goes. The same may be said of chapters XIII. to XVII., inclusive, which treat of presses for baling and other purposes, sheet metal working and forging machinery; hydraulic riveters; hand and power pumps, and steam pumps. Chapters XVIII. to XXI., inclusive, treat of turbines, including impulse or reaction wheels, Pelton wheels, etc. These chapters are largely of a theoretical nature, treating of the action of a stream of water on a curved vane, which necessarily involves some rather complicated mathematical discussions. Some practical examples of designing turbines to fill certain conditions are given, which should be useful to students. Chapter XXII. is a brief one of only four pages, on water wheels; all that is needed, however, for these obsolete machines. Chapter XXIII. treats at some length, 18 pages, on hydraulic engines, giving both theory and practice. The final chapter treats of "recent achievements," such as the 4,000-ton hydraulic lift dock at San Francisco, the lifts of the London Tower Bridge, water-balance inclined railways, the Glasgow Harbor tunnel lifts, a 4,000-ton forging press, and a brief account of the Niagara power plant.

WATER SUPPLY ENGINEERING.—The Designing, Construction and Maintenance of Water Supply Systems, both City and Irrigation. By A. Prescott Folwell, M. Am. Soc. C. E. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 6 × 9 ins.; pp. 502; 72 tables, 19 plates and 95 illustrations in the text. $4.

This is the most satisfactory American book aiming to cover the whole field of water-works design and construction that has appeared since the publication, 24 years ago, of the first edition of Mr. Fanning's "Treatise on Hydraulic and Water Supply Engineering." Although the latter book has had several revisions, none of them have been thorough, the latest one (1896) leaving numerous statistical tables and other matter dating from 1865 to 1875, in some cases with little or no intimation that conditions have materially changed in the past 25 to 35 years. While the whole field has not been traversed by any writer between Mr. Fanning and the present author, different portions of it have, however, been satisfactorily covered by a number of authors. This has been particularly true of the sections devoted to the quality of water, as is shown by the fact that within the past five years the publishers of the present volume, alone, have brought out no less than five books on this phase of water supply, in the following order: Hazen's "Filtration of Public Water Supplies;" Mason's "Water Supply (Considered Principally from a Sanitary Standpoint);" Fuertes' "Water and Public Health;" Whipple's Microscopy of Drinking Water;" and Mason's "Examination of Water (Chemical and Bacteriological)." During the same five years there have also appeared, along this same general line, Collet's "Water Softening and Purification," Hill's "Purification of Public Water Supplies" and Baker's "Potable Water and Methods of Detecting Impurities," besides the reports of Weston, Fuller, Hazen and others on water purification experiments. While these numerous works on the means of determining and improving the quality of water have been appearing, scarcely any additions, in the form of books, have been made to other branches of water-works engineering, save in hydraulics and the gradual expansion of Mr. E. Sherman Gould's "Simple Hydraulic Formulas" into his "Elements of Water Supply Engineering." The one exception to what has preceded, or the nearest approach, in both comprehensiveness and freshness, to a rival of the book under review, is Goodell's "Water-Works for Small Towns," published about the same time as this book by Mr. Folwell. Mr. Folwell's book is on much the same general lines as Mr. Fanning's, with the advantage of a pretty thorough review of all the recent periodical and other literature of the subject, but it lacks the originality and breadth of experience shown by Mr. Fanning's work. Mr. Goodell's book is less pretentious than either of the two others, but is compact and lucid, and covers a wide range of topics, the author supplementing his own ideas, in many cases, by citations from various engineers, sometimes letting others tell the whole story. Perhaps it ought to be noted that Mr. Goodell lays himself open to the criticism of having made his book too much an advertisement for the technical journal with which he is connected, and of having omitted all citations from rival publications; the latter, although limiting the value of his book, may be excused, as may the former, save for a few instances of seemingly inexcusable zeal in behalf of the advertising pages and various publications of the journal in question.

The foregoing has been written to indicate where Mr. Folwell's book stands in relation to others on water supply. From what has been said, we think it will be apparent that this volume will at once take the front rank, although it by no means supplants such a time-honored and valuable treatise as Fanning's "Water Supply," nor

limits the usefulness of the more specialized books on the quality of water or on hydraulics and similar topics.

A few words may now be said regarding the details of the plan and scope of the book. The volume is divided into three main sections, on "Designing," "Construction" and "Maintenance," but the first section takes up about 450 pages, leaving only 100 pages for the balance. The illustrations are, in the main, well chosen and fairly rendered. The tables include a large number of valuable data.

We regret to see that the author has adopted the misleading and objectionable terms, English and American filters, and are surprised at the latter part of the statement (p. 313) that the Anderson process of treating water "has been used in a number of places in Europe and this country." Aside from a few experimental plants, we are quite positive that the Anderson process was never tried in this country, and it seems to be declining in favor abroad (see Eng. News, Feb. 8, 1900, p. 93), but the latter did not become evident here until a short time ago. On p. 369, where mentioning supplies auxiliary and inferior in quality to the main supply, Rochester, N. Y., might well have been cited, for water has been drawn from the Genessee River in that city, for many years, to supply manufacturing establishments and for fire protection.

These are minor matters. The most serious criticisms we would make is that many practical details of design and construction, mostly small, perhaps, but still important, are omitted. Thus, the very day this review is written we have had an inquiry regarding the protection of water mains on bridges from freezing. Four lines in this book suggest that in some cases such pipe may be boxed in and the enclosed space filled with "mineral-wool, asbestos or some other non-conductor." This is practically all we can find on the subject, and Fanning and Goodell are no more helpful; unless all the indexes to the books in question are sadly at fault.

This may be considered so simple a matter as to need no fuller consideration in the book, but taking up the very important subject of the best types of valves and hydrants it is found that comparatively little is given on these topics, and that only one fire hydrant is shown in the illustrations. There is nothing whatever, at least in the index, on devices to indicate the water levels in distant stand-pipes and reservoirs, nor on the subject of pressure-recording gages. And yet, notwithstanding these and many other things one would like, but fails, to find in this book, the volume reaches the proportions indicated at the opening of this review. This suggests the possibility that the specializing recently shown in books on the quality of water and allied topics, and in hydraulics, will have to be extended to other branches of water-works engineering.

In conclusion, the present volume gives us much to be thankful for, and raises hopes for a more full treatment of this great subject in the future, in either a more comprehensive treatise or in a number of special ones.

ANNUAL CONVENTION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

The twenty-third annual meeting of this association was held at the Auditorium Hotel, Chicago, May 22, 23 and 24, with a large number of members in attendance. The first meeting was called to order about 11 a. m., May 22, and the President, Mr. S. T. Carnes, delivered a brief address. The report of the Secretary, Mr. Geo. F. Porter, showed a balance of $4,368.

The first subject to be taken up was the report of the Committee on:

The Investigation of the Photometric Value of Arc Lamps.

The report proper was quite brief, outlining the general scheme of investigation as formulated by the committee, and this was read by the chairman, Mr. Henry L. Doherty, of St. Paul, Minn. Prof. W. E. Goldsborough, of Purdue University, and one of the members of the committee, then introduced Prof. C. P. Matthews, who has conducted all the photometric work for the committee in the electrical department of the university, the use of which had been offered by the authorities of the university. Prof. Matthews gave an interesting account of the work thus far done, which has included the devising of special apparatus and methods for testing. The results obtained were also presented, but the report was simply one of progress, the investigations having by no means been completed. The discussion turned largely on the relative merits of direct-current and alternating current arc lamps, and it was stated that St. Louis, Atlanta and Pittsburg are now using 7½-ampere alternating current lamps. A vote of thanks was passed to the committee and its associates and to the authorities of Purdue University.

The afternoon session was not called to order until 3 p. m., and the first paper presented was one by Harry J. Frith, of Watseka, Ill., and F. A. Copeland, of La Crosse, Wis., on:

Exhaust Steam Heating.

The discussion was somewhat spirited, and there seemed to be a rather general disposition to discount the financial economy of the system as presented in the paper. Mr. W. L. Abbott, chief operating engineer of the Chicago Edison Co., then read a very interesting paper on:

Operating Economies in Central Station Practice.

He instanced methods of economy in the use of oil and waste, in the distribution of hours of labor, and in methods of firing. The efficiency of the firing of each boiler is tested by means of the econometer, an instrument showing the varying percentage of carbon dioxide in the flue gases. An abstract of this is given in another column. Prof. Goldsborough endorsed the author's ideas as to the greater efficiency of the working force when the men know that they are in line of promotion by merit, and not by favoritism. Mr. Doherty thought the practice of keeping a check on the firing economy by analyzing the flue gases is not as widely known or followed as it should be, since the item of fuel is one of the most important in which to effect an economy. With automatic stokers, even fed by gravity, the fuel economy is often very low, the firemen paying little attention to the fires and there being no check upon them. He described a German system of furnace in which a bed of incandescent coal 44 ins. deep is maintained, with a forced draft, realizing an unprecedented economy in fuel consumption. As to the saving of oil and waste, he thought that would be a minor matter in small stations, the saving of fuel being of much greater importance in such cases.

On May 23, the morning session was entirely taken up by the reading and discussion of a paper by Mr. James B. Cahoon, of Syracuse, N. Y., on the subject of:

Uniform Accounting.

This paper dealt somewhat forcibly with the question of municipal ownership, and described the negotiations with the League of American Municipalities for having an expert investigation made as to the cost of operating municipal plants. Several of the members thought that this question should not have been considered in the paper, and the discussion was limited to matters of accounting, it being decided to discuss the question of municipal ownership at an executive session. We shall give some extracts from this paper, from which it will be seen that Mr. Cahoon believes in including taxes as operating expenses, on the plan advocated by Mr. Stuyvesant Fish, President of the Illinois Central R. R., in our issues of March 29 and April 12. In the discussion it was pointed out that it would be very desirable to have the accounting done at more frequent intervals, either daily (as at banks) or at least weekly, so that there will be greater opportunity for introducing economies which a proper system of accounting will show to be desirable.

At the afternoon session, Mr. William L. Robb, of Hartford, Conn., read a paper on "Series Enclosed Alternating Arc Lighting for Street Lighting Service," from which we take the following paragraphs:

Series-Enclosed Alternating Arc Lamps.

The enclosed-arc lamp on constant potential circuits has now been in successful operation for about four years, and the series enclosed-arc lamp has been in equally successful operation for about two years.

The system of street lighting that will be found best for any city depends largely upon local conditions. But there are many cases where investigation will show that the adoption of the constant-current transformer and the series alternating enclosed-arc lamp will at present offer the best solution of the problem. In Hartford, where constant-current transformers have now been in use continuously for more than two years, we are at present operating 804 street lights, 700 of which are operated from constant-current transformers on series alternating-current circuits. The remaining lights are operated from a constant-potential Edison three-wire system. Eight constant-current transformers, each of 100-light capacity, are in use. Six of these have been installed in two transformer houses, at a distance from the central station, and are operated without any attendant. The 100-light transformers are arranged to operate two circuits of 50 lamps each.

The first lamps were trimmed every five days, but since adopting the caps now in use it has only been necessary during the long lighting hours of winter to trim once in six days. The trimming is taken care of by two trimmers, and from the results obtained we find that one trimmer, with horse and wagon, can easily take care of 500 lamps. This would make the annual cost of trimming, at the Hartford rate of wages, $2 per lamp, as against $8 per lamp when the open air arcs were used. The cost of carbons per lamp per year is $1.50 per lamp against $5.84 previously paid for open-air arcs. The cost of inspection has remained unchanged. The cost of inner globes now averages less than two globes per lamp per year, or about 30 cts. per lamp.

During the past six months the records show that out of 804 lamps, the "outages" amounted to 2.2 lamps out all the time. Actual experience has showed a saving in power of 150 watts per lamp, when 400-watt alternating-current lamps supplied from constant-current transformers replaced nominal 1,200-c. p. open-arc lamps. This, assuming the value of power at the switchboard as 1 ct. per kilowatt-hour, would mean an annual saving in the cost of power of $6 per lamp per year.

This led to quite a lengthy discussion, in the course of which the cost of trimming lamps was rather called in question. It was stated, however, that at Utica, N. Y., there are 600 enclosed arc lamps which are trimmed and cleaned by one man. After trimming 125 lamps and putting on new globes, he brings the dirty globes to the station, removes the carbon holder and cleans the globes on a machine having a revolving wet brush and dry cloth. The cleaning done in this way takes but about 80 minutes. Formerly six trimmers were employed.

Equitable, Uniform and Competitive [illegible]

This was the title of a long paper, read in [illegible] Mr Henry L. Doherty, of St. Paul, Minn., and it was listened to with great interest and attention. The main [illegible]ective systems described were as follows, the advan[illegible] and objections being given for each system: (1) [illegible] rates; (2) uniform meter rates; (3) meter rates [illegible]s on quantity of consumption; (4) meter rates with a [illegible]imum guarantee; (5) meter rates different on amou[illegible] time the maximum capacity of installation is used [illegible] York system); (6) meter rates varied by the amount [illegible]e the maximum demand is used (Wright demand sy[illegible] (7) meter rates varying according to time of day [illegible] which current is used (General Electric Co.'s two-ra[illegible]eter). Mr. Doherty proposed a new system, which [illegible]ready been tried at one plant, the object of this being [illegible]ncour-age customers to use more current and thus dim[illegible] their kilowatt cost.

During the afternoon, a resolution was adopt[illegible]rging the passage by Congress of the bill providing f[illegible]re es-tablishment of a national standardization bure[illegible].

At the morning session on May 24, two pa[illegible] were presented, upon which there was no discussion: "Automobiles as a Source of Revenue for Central Stati[illegible]," by Mr. Elmer A. Sperry, of Cleveland, O.; and "Combination Electric Lighting, Power and Railway W[illegible]," by Mr. R. S. Feicht, of Pittsburg, Pa.

During the convention, several committee re[illegible] were presented, some extracts from which are given below. The report of the Committee on Legislative Policy was presented at the executive session and was not made public.

Grounded Circuits.

This report contained the following paragraphs:

The grounding of the neutral wire in direct-current, three-wire, low-potential systems has been declared an extremely dangerous practice by some eminent professors, nearly all fire insurance officers and inspectors, and some prominent workers in the electrical field. Nearly all fire insurance boards have issued their edict against this practice; but, notwithstanding their opposition, it is now almost the universal practice to permanently ground the neutral wire. Experience has shown that this practice has not increased the fire hazard or losses by fire, but on the contrary it is fair to presume that it has decreased both hazard and loss.

As to the permanent "grounding" of one side of the secondary circuit, while it is not an absolute preventative of accidents to person and property, yet it is a step in the right direction, and, if adopted, will add greatly to the safety of the public and reduce the hazards attending the transmission of electrical energy by what is known as the alternating or transformer system.

Standardization of Electrical Apparatus.

This report recommended the approval by the Association of the final report on the same subject issued by the American Institute of Electrical Engineers. As to the advisability of preparing standard specifications, it was considered that the consideration of the technical questions is now so far advanced that the commercial questions may be taken up in their turn.

Standard Candle-Power of Incandescent Lamps.

The committee reported that it has been unable to get the lamps of 110 and 220 volts prepared at Columbia University, and these can be obtained through the secretary of the Association. The committee is also preparing plans and specifications for a standard photometer room and its equipment. It is believed that the time has come for careful photometric tests of all samples rather than for merely maximum and minimum tests, since lamp manufacture has so far advanced that, if the maximum and minimum tests only were to be used, there might be a strong tendency on the part of the manufacturer to work toward the inferior or superior limit.

Freight Classification.

The committe reported that it has been unable to get the railways to harmonize the classification of electrical apparatus with that of other machinery, and recommended the employment of counsel to bring the matter up in the courts. This recommendation was referred to the executive committee.

Standard Rules.

The committee stated that its policy has been not to make changes unless absolutely necessary.

The thickness of interior conduit, lined or unlined, has been established, and commercial gas-pipe taken as the standard.

Weatherproof wire, so-called, is tabooed for interior construction unless covered with a slow-burning material.

A standard of thickness of insulation on wire, after a conference with the manufacturers, has been established.

The much-vexed question of the proper distance between fuse terminals has been determined, as well as the distance between fuse metals of opposite polarity. Switches are now being standardized as to the proper breaking distance between poles, etc.

The rules have been changed so as to permit the running of two more small motors in series multiple or multiple on constant-potential circuits.

Rubber insulation is not now insisted on for flexible-cord pendants in dry places, but an elastic slow-burning material may be used.

The officers elected for the ensuing year are as follows: President, James B. Cahoon, Syracuse, N. Y.; First Vice-President, Louis A. Ferguson, Chicago, Ill.; Second Vice-President, W. Worth Bean, St. Joseph, Mich.